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ABSTRACT

Subjects addressed by the 55 papers in this proceedings include: teaching literacy; hypermedia navigation and design; creating a community of thinkers; analysis-based message design; learner-instruction interactions; representation of time-based information in visual design; presentation interference; professional development through anecdotes; cybercourse model design and implications; computer-based instructional simulation; effects of computer conferencing and multiple intelligences on expository writing; promoting self-esteem, achievement, and multicultural understanding through distance learning; computer use when universally available; university academic achievement in a distance education setting; START (Student Trainers as Resource Technologists); improving oral, writing, and thinking skills; developing effective instruction; improving mathematics instruction using technology; design model for learner-centered, computer-based simulations; open-ended learning environments; how local school districts formulate educational technology policy; inductive multimedia programs; creating electronic learning environments; instructional technology research; the foundations of the field; systematic change in education; software needs of public and higher education; hypertext processing; narrative versus step-by-step computer instruction; managing performance-based learning; reflection as a means of developing expertise in problem solving, decision making, and complex thinking of designers; effect of color-coding on locus of control; interaction and collaboration via computer conferencing; the STEPS (Support for Teachers Enhancing Performance in Schools) tool for instructional planning; pre-service teacher preparation; facilitating teachers' Internet use; two-way audio/video distance education environments; learner ability and control; interaction patterns in distance education; visual literacy instruction; designing multimedia for college engineering courses; preK-12 educators' information needs; physical place and lived topographies; enhancing course offerings using interactive technologies; awareness of cognitive style in hypermedia; restructuring course delivery; university faculty Internet use; evaluation of a graduate seminar conducted by listserv; computer-assisted automation of multiplication facts in elementary schools; intergenerational electronic communications in the curriculum; observation skills training for health care professionals; integrated learning systems; and personalized independent learning systems. ERIC document numbers of previous AECT (Association of Educational Communications and Technology) proceedings, AECT Research and Theory Division officers and board, and paper reviewers are listed, and an AECT membership application and fact sheet are included. (DLS)

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20th Annual Proceedings
Preface

For the twentieth year, the Research and Theory Division of the Association for Educational Communciations and Technology (AECT) is sponsoring the publication of these Proceedings. Papers published in this volume were presented at the National AECT Convention in St. Louis, MO. A limited quantity of this volume were printed and sold. It is available on microfiche through the Educational Resources Clearinghouse (ERIC) system.

REFEREEING PROCESS: All research papers selected for presentation at the AECT convention and included in this Proceedings were subjected to a rigorous blind reviewing process. All references to author were removed from proposals before they were submitted to referees for review. Approximately fifty percent of the manuscripts submitted for consideration were selected for presentation at the convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

A selected number of development papers, sponsored by the Division for Instructional Development (DID), are included in this Proceedings. The most important instructional development papers were selected by the DID program chairs for publication.

This volume is indexed by both author and descriptors. The index for volumes 1-6 (1979-84) is included in the 1986 Proceedings, and the index for volumes 7-10 is in the 1988 Proceedings. After 1988, each volume contains indexes for that year only.

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AECT began as the Department of Visual Instruction at the National Education Association in 1923, in the days when visual aids consisted of films and slides. In 1947, as educators were adapting technology used to train World War II service personnel for the classroom, the name of the organization became the Department of Visual Instruction (DAVI). Twelve years later, DAVI became an affiliate of the NEA and finally the autonomous association, AECT, in 1974.

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An Instructional Model for Teaching Literacy: Implications for Instructional Theory

Charoula Angeli
Indiana University

Abstract

The purpose of this research was the development of a learner-centered instructional model for the teaching of reading and writing skills. Specifically, the 14 APA learner-centered principles have been used as the conceptual framework for the development of the model. There are seven iterative instructional events that comprise the instructional model, and they are: (1) Establish rapport with the learner; (2) Engage in informal conversation; (3) Make the transition from informal conversation to structured dialogue; (4) Promote awareness of correct spelling and proper sentence structure; (5) Facilitate the construction of symbolic knowledge; (6) Promote reflection; and (7) Encourage the learner to assume higher agency in his or her learning. The model has been developed using qualitative methods of research and 50 elementary school children participated in the study. Lastly, this study promotes a learner-centered paradigm of instruction, one that is fundamentally different from traditional practices, as it places the learner in the center of the learning process and emphasizes meeting individual learning needs at different rates.

Introduction

There is no doubt that one of the most controversial issues in education for several decades has been the teaching of literacy (Noll, 1995). The debate has often centered on two different approaches of teaching reading and writing, namely the phonics approach and the whole language approach. Advocates of the phonics approach (e.g., Chall, 1967; 1989) argue that the whole language approach is not an effective method for teaching literacy, because it does not provide enough structure. On the other side of the debate, Goodman (1986), an advocate of the whole language approach, asserts that the phonics approach makes language learning difficult, because it does not take into consideration the needs and experiences of learners. No matter which side of the debate one belongs to, the fact that there are currently 14 million children in the United States who have failed to reach satisfactory levels of literacy cries for our immediate attention, fresh conceptions of literacy, and innovative ways to support its development.

One promising approach has been to focus on the importance of dialogue in literacy. Vygotsky (1962) has proposed that learning is a social process, and that children first learn "social speech," talk directed at others, in their attempt to communicate with their significant others. He argues that children's social speech is later turned inwards, and experienced as thought. Oakshott (1962) draws attention to the critical relationship between language, thought, and dialogue. He hypothesizes that humans have evolved a dialogic competence that is both private and public. This dialogue can take place in collaboration with other people in a social environment, or it can take place within ourselves in the form of an internal dialogue, often called reflective thought.

Tharp and Gallimore (1988) assert that literacy events should be experienced by learners as collaborative social activities with goals embedded in natural settings, and not as isolated and decontextualized events. Along the same line of reasoning, Bruffee (1984), who views dialogue as a vital element in composing thoughts, claims that collaborative writing groups provide the social context and the structure for such dialogue to take place. In arguing that all knowledge is constructed and that social interactions are critical in knowledge construction, he lays the theoretical groundwork for using dialogues and conversations among socially interacting people jointly negotiating text. Hall (1987) also agrees that learners develop acceptable literacy skills when they are involved in meaningful and collaborative activities.

As Downing (1979) asserts, however, literacy involves a mark-making and interpretive process that requires explicit awareness of the meta-linguistic aspects of language. Awareness of those aspects of language required for literacy does not develop spontaneously from spoken language; they are inaccessible to one's consciousness without the aid of a teacher, mentor, or collaborative community. Hence, what is required for literacy is a language awareness support structure, which incorporates the more conscious, deliberate, meta-linguistic processes that help make meaning in reading and writing.

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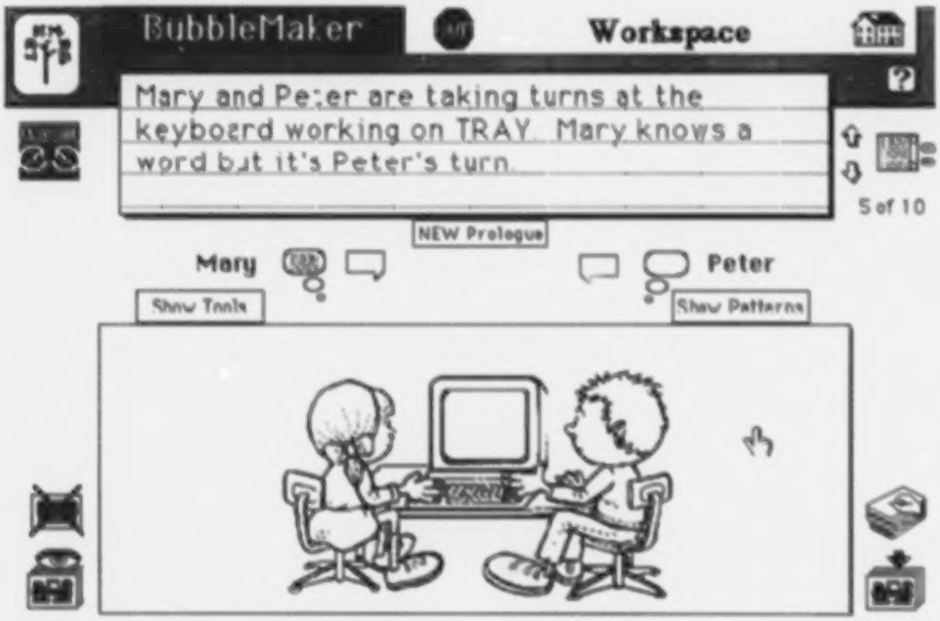
Bubble Dialogue, a computer software tool developed by the Language Development and Hypermedia Research Group (Cunningham et al., 1992), was designed to provide such a language awareness support structure for the acquisition of literacy. In this study, 50 elementary school children used Bubble Dialogue as a tool to help them improve their reading and writing skills. Before I proceed, I would like to first introduce Bubble Dialogue and discuss briefly the language awareness structure it supports.

Bubble Dialogue

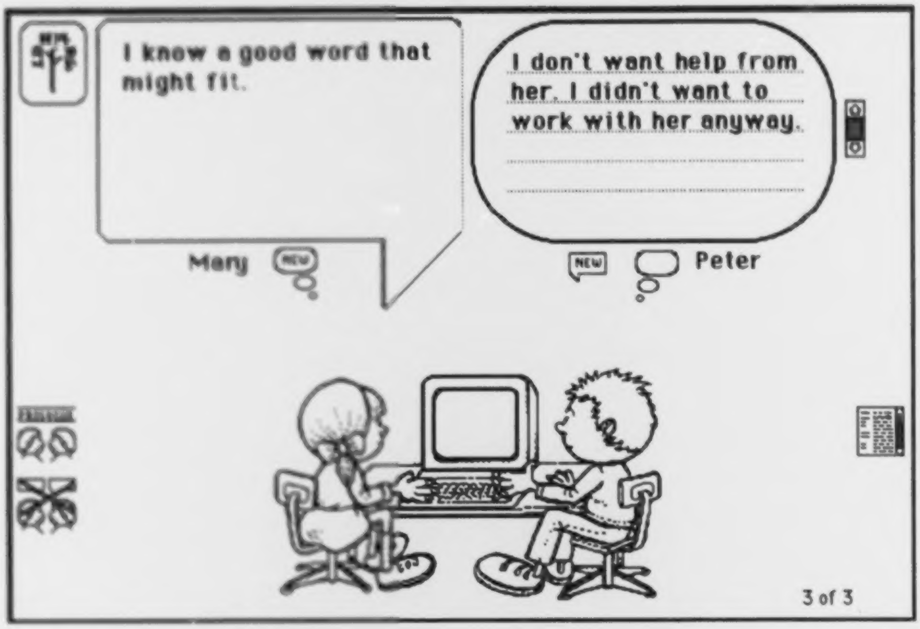
Bubble Dialogue is a HyperCard application that combines elements of role play, comic strip creation, and reflexive dialogue analysis (The Language Development and Hypermedia Research Group, 1992). A master stack, called BubbleMaker (see Figure 1) has been written to create customized Bubble Dialogue stacks for later use. The scene in which the discussion is to take place is established by the participants. A graphic is then chosen, and the setting is described by writing a prologue. In each customized stack created by BubbleMaker, four icons, representing a speech bubble (public/social speech) and a think bubble (inner speech) per character, are presented alongside at least two characters on the screen. The comic genre is so well established in many cultures that even very young children, when presented with empty bubbles, feel compelled to speak for the characters playing out their roles.



Mary and Peter are taking turns at the keyboard working on TRAY. Mary knows a word but it's Peter's turn.

Figure 1. The BubbleMaker workspace

Bubble Dialogue can operate in two distinct modes; the creation mode and the review mode. In the creation mode (see Figure 2), one can only move forward to the next empty think or speech bubble. When in this generative mode, the course of action is transferred to the other character once a speech, and optionally, one think bubble have been used. This turn-taking protocol ensures that a user cannot have an extended conversation with himself or herself.



I know a good word that might fit.

I don't want help from her. I didn't want to work with her anyway.

Figure 2. The tool in creation mode

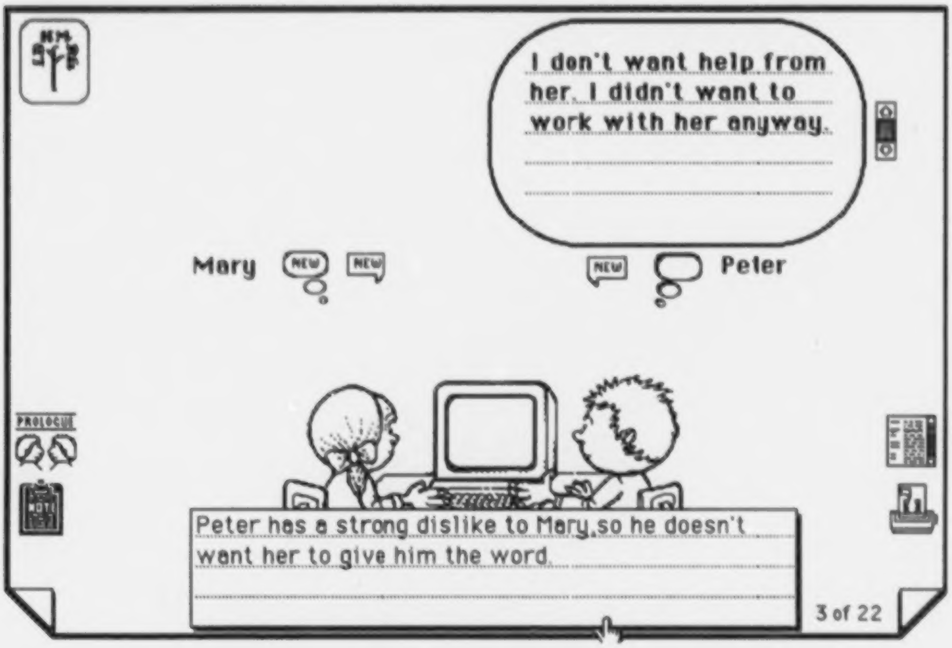
In contrast, in review mode (see Figure 3), the user can move forward or backward to add notes, edit existing bubbles, or even extend the dialogue. Most importantly, the review mode provides the user with an opportunity to reflect on the dialogue that took place, as well as the quality of his or her writing. One of the features that is activated while the application is in review mode is the notes field. This feature is powerful in a variety of ways. For example, when users review their dialogues they can use the notes field to add comments about "what's happening," or comments on the motives and feelings of the characters. Teachers and researchers may also use this feature to annotate the dialogues in any manner they see fit, such as commentary, reminders, and questions for the users to consider as they review their work.

All these features of Bubble Dialogue make up the language awareness support structure that is needed for learners to make the transition from conversation to written dialectic discourse. Think and speech bubbles enable the learner to function in both the interpersonal and intrapersonal levels (Vygotsky, 1962), as well as learn to take turns in a dialogue. In addition, the review mode allows learners to reflect and revise their dialogues appropriately.

Research Participants

Bubble Dialogue was used in collaboration with school children to write stories. Fifty elementary school children in a midwestern city of about 60,000 used Bubble Dialogue over a period of seven months. Thirty of those students were in second grade, five were in third grade, and fifteen were students from a multiage classroom for fourth, fifth, and sixth grade levels. Fifteen of the fifty students were reported as students with special needs, and five were identified as gifted. Thirty-eight of the students were Caucasian, ten were African-American, one Hispanic-American, and one American-Indian.

Bubble Dialogue sessions lasted for about 45 minutes to 60 minutes each. Younger children (i.e., first, second, and third graders) needed more time to get used to the computer tool and to type their responses. Each story the children wrote was saved in a file by Bubble Dialogue and was printed out at the end of each session.



I don't want help from her. I didn't want to work with her anyway.

Peter has a strong dislike to Mary,so he doesn't want her to give him the word.

Figure 3. The tool in review mode

Theoretical Framework

The instructional model that is developed is based on learner-centered principles for learning and instruction. The 14 learner-centered psychological principles (LCPs) provide a good framework for curriculum design and instruction (American Psychological Association, 1995). The principles are divided into four categories: (1) Cognitive and metacognitive; (2) Motivational and affective; (3) Developmental and social; and (4) Individual differences.

In brief, the LCPs state that learning occurs more effectively when it is an intentional process of constructing meaning from experience and information. This view emphasizes that learners need the support and instructional guidance of a mentor, coach, or collaborative community to learn how to create meaningful representations of knowledge and engage in projects that will help them pursue their goals. In addition, learners need assistance in constructing and integrating new knowledge with existing knowledge, in part, by using a variety of cognitive strategies. Salient in the 14 LCPs is the development of the learner's thinking processes and strategies. Successful learners are the ones who are engaged in problem-solving and reflection, have developed reasoning skills, and know how to apply prior knowledge to new situations. But the LCPs also emphasize the importance of motivation. Curiosity, perceived relevance of the task to the learner's goals, and personal choice and control, for instance, are all factors that contribute to a learner's motivation. Learning is also influenced by the learner's developmental level, as well as by how he or she interacts in social environments when collaborating with others.

Instructional Model

I would like now to discuss the instructional model that is modeled after the learner-centered principles for learning and instruction Based on the design characteristics of Bubble Dialogue and the theoretical framework of LCPs, I developed the instructional model shown in Figure 4 below.

In accordance with the LCPs, learning and instruction were viewed as cognitive, metacognitive, developmental, and social processes. Instruction, therefore, took on many different dimensional forms but always within the framework of dialectic discourse.

The instructional process, shown in Figure 4 above, consisted of seven different phases.

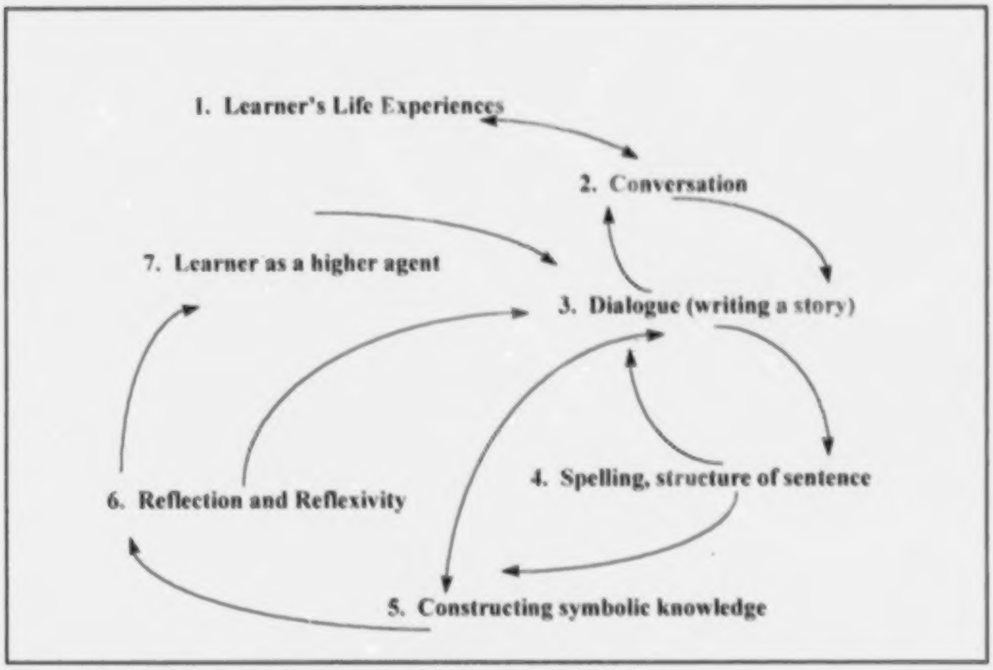

1. Learner's Life Experiences
2. Conversation
7. Learner as a higher agent
3. Dialogue (writing a story)
4. Spelling, structure of sentence
6. Reflection and Reflexivity
5. Constructing symbolic knowledge

Figure 4. The collaborative learner-centered instructional model

Phase I

First of all, the researcher established rapport with the students. The goal during this first stage was to get to know the students better and inform them of the purpose of the computer activity. Even though it was desired to make the instructional process purposive and intentional, the researcher also wanted the students to find the task relevant to their interests. As Short and Burke (1991) state, "whenever students are involved in experiences where they have choices, there is a greater likelihood that they will be able to make choices that allow them to connect with what they already know" (pg. 36). Therefore, students were asked to draw from their life experiences and select the topic they wanted to write a story about. Older students (in third, fourth, fifth, and sixth grade levels) easily referred to their family life or hobbies to select the topic they were interested in talking about, but when the younger second-graders were given the option to choose, they claimed that they did not know what they wanted to talk about. Therefore, this introductory phase lasted longer with second-graders, as they needed more help in selecting a topic that was of interest to them.

Phase II

After the researcher and the students established a topic, they engaged in purposive conversation to learn more about it. Though this phase did not last long, it was used as a bridge to shift from casual conversation to conscious dialogue. Initially, all children found it difficult to get familiar with the structure of dialectic discourse that Bubble Dialogue provided. The students had to be constantly reminded that they had to use the computer to type their responses in either a speech or a think bubble.

Phase III

Once the transition from conversation to dialogue was modeled, the researcher modeled using the speech and think bubbles for the students, and asked them if they knew the difference between the two. Since many students initially felt hesitant and unsure about the use of think bubbles, they avoided them. The researcher continued modeling their uses for the students, and noticed that after four or five speech bubbles, they tried at least one think bubble.

Phase IV

Once the students felt comfortable with Bubble Dialogue, the researcher asked some of them to read aloud what they were typing in the bubbles. The reason for this request was to increase their metacognitive awareness about the mechanics of their language use, since many of them were misspelling words and writing sentences that were not grammatically correct. Once they began reading aloud what they wrote, they became aware of the fact that what they wrote did not "sound" too well. Accordingly, they began asking questions about how to spell certain words, if they used punctuation correctly, and if their sentences were well-formed.

Postman (1995) states that "there are many ways to teach the young the connections between language and world-making" (pg. 84), and he argues that teachers make a major mistake by focusing students' language use on how to spell words correctly and use punctuation rules properly. Therefore, literacy becomes a game of trivia. As a result, during the fourth phase, the role of the researcher as the "teacher" became extremely difficult and challenging. As Sternberg and Horvath (1995) note, a good teacher is one that is insightful and one that holds a bag of different tools to use appropriately. Since not all students were at the same level of language development, the biggest challenge for the researcher was to diagnose when the time was right to make a student aware about the technical aspects of language. Some (10%) students were aware from the beginning about their language use by just watching the way the researcher wrote. More (60%) gradually became aware of their writing as the researcher was constantly asking them questions to think about their writing. The remaining students (30%) failed to discriminate between the researcher's writing and their writing.

Cunningham (1992) states that knowledge does not consist of a number of objects that learners acquire, instead knowledge is better thought of as knowing or as a process. In tandem with this notion, literacy was viewed as a process of how learners come to mature thought and reason about abstract concepts (Bruner, 1966) and world-views (Postman, 1995). At the same time, it was recognized that it was important to learn how to write correctly. The strategy for dealing effectively with a number of different zones of proximal development (Vygotsky, 1962), therefore, was to first assess the readiness of students for new learning, and then, through a process of appropriation (Rogoff, 1990), introduce them to grammatical and punctuation rules by using language to talk about language. Therefore, not all children entered the fourth phase at the same pace. For those students (10%) who were aware about their language use from the beginning, the instructional process shown in Figure 4 above was systematically used in a linear fashion. In contrast, students who gradually became aware of their writing (60%), were guided from phase three to five and returned to four at a later time. There were two reasons for this tactic; (1) the researcher wanted the students to question by themselves the quality of their writing, and ask for help when they felt they needed it, and (2) the researcher did not want students to think that the only goal of the activity was to learn punctuation and grammatical rules. The rest of them (30%) were also guided from phase three to five and returned to four when the researcher felt that it was appropriate to introduce language mechanics.

Phase V

During the fifth phase, the goal was to help children develop their cognitive skills by asking them questions about the topic they selected. Initially, the researcher's questions were simple and required them to recall certain facts. Gradually, she shifted to questions seeking their personal experiences to reason and make inferences about the topic. For example, if the topic was friends, she asked questions such as: "Why do you like Tim as a friend?", "What qualities should a friend have?", "Are friends important?", "What do you do to be a good friend to somebody?". The goal was to activate their belief system about friendship through a process of inductive and deductive questioning. When the question was one that they had not encountered before, the researcher helped them to build a context within which the question could be answered meaningfully.

This last process is known as abduction (Cunningham 1992; Shank, 1987). The instructional strategy used for fostering abduction was to present students with a perspective different than their own; most of the time this was the researcher's own perspective. Therefore, students came to know how their knowledge templates and belief system were situated in relation to somebody else's belief system, while enhancing theirs as needed.

Phase VI

The sixth phase of reflection and reflexivity[1] was also of particular interest. Promoting reflection and reflexivity was an instructional strategy that was used primarily to help students develop metacognitive and higher-order thinking skills. The terms reflection and reflexivity are defined as "reflection of our reflections, thinking about our thinking process, knowing how we know" (Cunningham, 1992, p.187). The researcher's goal was to encourage students to think about the dialectic discourse reported in speech bubbles, analyze the arguments presented, synthesize all that was said so far, edit and revise appropriately, and decide how to respond next.

The findings indicate that students found it either difficult or irrelevant to use think bubbles as they made limited use of them. Nonetheless, when they did employ them, they used them to evaluate their current state of knowledge and say "I don't know, why is she asking me that question?", or express a concern they had about what the other person had said. When the researcher asked students why they were not using think bubbles as much as intended, they responded that they did not have to think about what to say, they already knew. However, as it was observed, students stopped and thought on numerous occasions about their answer without using a think bubble. Therefore, it seems that students either felt that it was too much work to type in their thoughts, or they did not see the connection between speech and think bubbles and how they could use both to shape their internal and external dialogue. It is the researcher's belief that a certain amount of practice with Bubble Dialogue is needed for a student to make the connection between think and speech bubbles. It was also expected that the notes field feature of Bubble Dialogue would provide an appropriate opportunity for reflexivity to take place, but students also made limited use of this feature. Here, again, it is proposed that with increased use of Bubble Dialogue, reflexive use of the notes field and other features will increase.

Phase VII

In all six stages of the instructional process used here, the "teacher" provided scaffolding while the student was constructing a set of negotiated beliefs. But even in this prevailing teaching model it was the teacher who asked questions, directed inquiry, and provided direction. As a result, the learners were dependent on the teacher's assessment of what constitutes knowledge, because the teacher was the one who was in control of movements within the zone of proximal development (ZPD). To help them grow out of this dependency, the researcher tried another activity using Bubble Dialogue which encouraged learners to assume higher levels of agency in their learning process by asking the questions, thus directing the dialogue. This movement out of dependency is really a question of ZPD control. Therefore, in attempting to shift control of the ZPD from the teacher's control to mutual control, the researcher hoped to balance the learning process. Previous research (e.g., Brown & Palinscar, 1989; Palinscar, 1986; Scardamalia & Bereiter, 1985) has shown that such a shift in power and control can be achieved only in learning environments that support the dialectic process, wherein learners with the appropriate scaffolding take over the asking of questions, and, thereby, direct their own inquiry. Bubble Dialogue proved to be an effective vehicle for supporting the development of such student self agency. Student opportunities for self agency are evident in the analyses of this study's dialectic discourse.

Implications for Instructional Theory

I would like now to discuss the implications of this research study for instructional theory and practice. Reigeluth (in press) advocates a new paradigm of instructional theory, a learner-focused paradigm as he calls it. The term instructional theory here is used the same way as Reigeluth uses it, that is instructional theory is a design theory that offers guidance on how to facilitate people's learning. Traditionally, instructional practices emphasized the fulfillment of learning goals, always pre-determined by the teacher, at specific rates. In other words, all learners were expected to reach the same learning goals at the same amount of time. Therefore, teaching has been viewed as a mechanical process of disseminating information to learners; a one-way interaction originating from the teacher to a group of learners.

What really the findings of this study show is that teaching and learning cannot be viewed as one-way interactions, but instead as collaborative processes situated in real, authentic, and social contexts in which the goal is to meet each learner's individual needs. As it was discussed earlier, not all learners in this study were able to complete all instructional events at the same time. As it was indicated, instructional time varied from 45 to 60 minutes. Therefore, instructional theory should be adaptive in nature. What I mean by adaptive is (1) to be able to customize instruction accordingly to adhere to the needs of each learner, and (2) to allow learners to attain competencies at different rates.

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[1] Cunningham (1992) differentiates reflexivity from reflection, but in this paper there is no distinction between the two.

Another finding from this research indicates that learners should be encouraged to assume higher levels of agency in their learning. Traditionally, the teacher has been the primary agent that controlled the zone of proximal development of each learner by dictating what needs to be learned, when, and in what sequence. The role of the teacher in this new paradigm of instructional design theory is still of paramount importance, but different. In this study, the teacher and the learner worked together to design an instructional episode with Bubble Dialogue (to remind the reader, the first event in the model is the establishment of rapport with the student in order to decide what story the student wants to write using Bubble Dialogue). It is important to have shared control in this learner-focused paradigm. The student should be asked to make certain decisions, thus allowing him or her to direct the learning process in a way that is relevant and motivating to him or her, not relevant or motivating to the teacher.

Lastly, I would like to stress the importance of designing instruction that is situated in a real activity that makes sense to the learner. Within the context of authentic activities learning new information becomes meaningful and relevant. Therefore, knowledge does not remain inert (Whitehead, 1957), instead it becomes usable. In this research study, learners learned about spelling and how to construct well-formed sentences within the context of writing a story as a collaborative activity between them and the teacher. In other words, the teaching of literacy was not approached as an act of disseminating decontextualized knowledge to the learners. When the teachers of the school children read the stories the children wrote, they were amazed by how different the children's written speech appeared from the one in their journals. Specifically, they noticed that in general students wrote more than what they usually wrote in their journals, formed better sentences, and made less spelling mistakes.

Conclusion

In this paper I discussed the development of a learner-centered instructional model for the teaching of literacy. The instructional model is based on the theoretical framework of the 14 APA learner-centered principles for learning and instruction, and it consists of seven distinct instructional phases or events. They are: (1) Establishment of rapport with learners; (2) Engagement in informal conversation; (3) Transition from informal conversation to dialogue; (4) Awareness of spelling and sentence structure; (5) Construction of symbolic knowledge; (6) Reflection; and (7) Promotion of learners as higher agents in the learning process. I then discussed how this instructional model calls for a new paradigm of instructional theory; one that places the learner in the center of the learning process, and one that breaks away from the notion that learning requirements should be fulfilled by all learners at the same time. Finally, I emphasized the importance of designing instruction that is relevant and meaningful to learners.

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Hypermedia Navigation: Where Do We Go from Here?

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As we begin the second decade of the development of hypermedia applications for personal computers, it seems appropriate to examine perhaps the most critical issue in the design of large hypermedia databases, namely navigation. Applications designed today look and feel quite different from those created over ten years ago. The difference is more than the addition of color. Today's applications employ different strategies or philosophies for navigation. As the navigation metaphor suggests, learners must move about in a database in order to access the information stored in it. With a small view screen, effective navigation is of paramount importance for complex and possibly vast hyperspaces. Clearly the method by which a user selects relevant information and instruction to appear on the screen in this computer environment will have a great deal to do with effectiveness of the resulting instruction.

Although theorists in such fields as educational technology, computer science, psychology, and education have written extensively about the components of good instructional design, the application of these theories to hypermedia has not always been satisfactory. Compounding the problem is the fact that many of the proposed theories conflict. Research into the effectiveness of various hypermedia designs is still in its youth. Consequently, there are currently no convenient foolproof rules to guide hypermedia designers. This paper will examine the main issues in hypermedia navigation, propose research questions, and suggest a methodology for resolving those questions.

What Is Navigation?

Navigation implies controlled movement from place to place. *The American Heritage Dictionary* (2nd ed., 1982) defines navigation to be "the theory and practice of navigating, especially the charting of a course for a ship or aircraft" (p. 833). Newer electronic publications do not significantly extend that older definition even though they themselves refer to "navigation" within their own hypermedia applications. For example, the *Grolier Multimedia Encyclopedia* (Version 8.0.3, 1996) defined navigation to be "the art and science of conducting a ship, airplane, or spacecraft safely and expeditiously to a specific destination. In the broadest sense anyone faced with the problem of 'finding the way' is a navigator, whether he or she travels on land, at sea, in the air, or in space" (Art. 21239).

As Conklin (1987) pointed out, the word "navigation," when applied to hypermedia applications, takes on a distinctly different meaning. In the world inside a computer, the traveler no longer need be on a ship or plane and to physically chart a course of travel in the sense of the dictionary definition. The concept of navigation in hypermedia refers to figurative movement within a potentially complex database of links and nodes, rather than physical movement.

The term navigation has become a metaphor for motion. Gygi (1990) stated that "navigation is a metaphor used to impart some sense of intentionality as well as spatiality" (p. 281). She pointed out that in hypermedia applications information is not brought to the user; rather the user must visit different places in the database to access the information. Sellen and Nicol (1990) reported that users make heavy use of spatial metaphors such as saying they are lost, they have reached a dead-end, they are going up and down to different levels, and they are moving forward and backward. Sellen and Nicol (1990) contended that users often construct spatial mental models to enable them to deal with "moving" from one context to another within a computer application. Such mental models are helpful for users to navigate even though the models do not in any way represent the actual physical location of information within the database itself.

Gygi (1990) and McAleese (1989) drew a distinction between browsing and navigation. They explained that browsing refers to users' discovering information by traversing the entire database in an unconstrained, even random, manner, whereas navigation refers to users' searching for information in a purposeful way in portions of the database where they can reasonably expect to find what they want to know. Canter, Rivers, and Storrs (1985) developed five categories for user navigation: *scanning* means covering a large area without much depth; *browsing* is following any path until an area of interest appears; *searching* means striving to find an explicit target; *exploring* is finding out the extent and nature of the database; and *wandering* signifies purposeless and erratic travel with recursion (revisiting nodes). McAleese (1989) and Horney (1993) attempted to characterize these different types of navigation by studying the navigational patterns of users. All five of these categories may be considered to be subsumed under the general heading of navigation.

Design Problems in Hypermedia Databases

Long before hypertext was a concept hatched in Vannevar Bush's fertile mind (Bush, 1945), the navigation of information loomed large as a consideration in learning environments. When such instructional materials are stored in a computer, designers no longer have the luxury of physical space afforded them in other teaching environments such as classrooms with extensive chalkboards, walls, or even tables to spread out materials. With computers, all exchanges between learners and instructional materials must be conducted through the myopic eye of a computer screen. Educators proficient in using wide-angle-lens techniques listed above to bring the world to their students must now constrain themselves to using a technology that views the world through a relatively restrained aperture.

In the emerging field of hypermedia instruction, becoming lost or disoriented is potentially the most difficult design problem to solve. The number of theories about the best way to navigate in hypermedia databases far surpass the amount of research that has been performed to justify those theories. Compounding the problem is the fact that many of the proposed theories conflict. The current cost of producing professional hypermedia applications for research purposes is so high that this trend is likely to continue for some time. From a user-centered point of view, it would appear that hypermedia applications should provide users with an entire arsenal of navigational tools, rather than force them to rely on just one strategy that may not necessarily suit them.

The implementation of non-linear access to many forms of information — text, sound, still images, video, animation, and the like — in one package driven by a computer is a recent development in education, not much more than ten years old. Although theorists in such fields as educational technology, computer science, psychology, and education have written extensively about the components of good instructional design, the application of these theories to hypermedia has not always been satisfactory. Research into the effectiveness of various hypermedia designs is still in its infancy. At present, there are no convenient rules to guide hypermedia designers. Consequently, the design of hypermedia applications is an *art* and likely will remain so for the foreseeable future.

Perhaps the foremost question in navigation is how to avoid becoming "lost in hyperspace." The questions considered below attempt to examine the potential causes of and cures for disorientation. A second idea for consideration is whether or not "hypermaps" should be provided. In a hypermedia application, not every piece of information needs to be explicitly linked to every other piece of information and, hence, a third area of interest is the balance between links and nodes. How many links are necessary and sufficient to do the job? Lastly, what level of learner control is advisable? Users choose where to go, but should they have the freedom to go anywhere?

The purpose of the questions raised is to attempt to systematize some of the choices developers must make when they design hypermedia databases. A second consideration is whether the hypermedia applications created ten years ago (when hypermedia environments were first became practical realities) can be significantly improved by introducing those features that are currently being advocated by hypermedia designers.

How Can Users Avoid Becoming Lost in Hyperspace?

Many authors have agreed that a major problem, if not the major problem, confronting users of hypermedia systems is becoming *lost in hyperspace* (Bernstein, 1991; Conklin, 1987; Jonassen & Grabinger, 1990; Locatis, Letourneau, & Banvard, 1989; Marchionini, 1988; Parunak, 1989; Shneiderman & Kearsley, 1989; Stanton, Taylor, & Tweedie, 1992). Stanton et al. (1992) pointed out there are inherent problems in navigating through a computer world that appears to be two-dimensional, although the underlying structure or metaphor may be three-dimensional. Picher, Berk, Devlin, and Pugh (1991) argued that getting lost in hyper*media* applications is more likely than getting lost in hyper*text* documents because the rules for navigating through nodes containing video, pictures, and sound are necessarily more complex than navigating text alone. In fact, Bernstein (1991) and Jonassen (1989) contended that users who fear they are overlooking crucial information because of navigation problems may abandon hypermedia in favor of regular materials.

Shneiderman and Kearsley (1989) posited that there are two aspects to being lost in hyperspace: not finding desired information and getting disoriented. They referred to this problem as the "dark side" (p. 10) of having the freedom to explore easily in hypertext. Edwards and Hardman (1989) listed three conditions wherein users are "lost": (a) not knowing where to go next; (b) knowing where to go next, but not how to get there; and (c) not knowing where they are in the overall structure of the document. Conklin (1987) also cited the last two conditions and called them a "disorientation problem" (p. 38). Bernstein (1991) pointed out yet another facet of disorientation. He maintained that an unexpected recursion (return to a previously-visited node) is intrinsically disorienting, especially when such recursions are rare. Users may perceive recursion as a signal that the database has been exhausted or that there has been a system error. He explained that some authors of hypermedia novels such as mysteries may want to intentionally disorient the reader by using recursion, but that in general unexpected recursion is to be avoided.

McAleese (1989) noted attempts for combating the lost-in-hyperspace syndrome in two well-known applications. In NoteCards, a Graphical History Tree records and displays the "neighborhood" of nodes that have been visited by the user. The nodes are marked so that users can see which links they have used. While a plain History Tree displays all accessed nodes in an hierarchical trail, a Summary Tree is a special case of a History Tree where annotations made by the users are also displayed. McAleese pointed out that HyperCard has a Summary Window, that users can activate by using the Recent command, which displays as many as the last 42 distinct cards/screens visited, but not the links used, and allows users to jump to any one of those cards/screens by clicking on its image. Fujihara, Snell, and Boyle (1992) applauded systems such as the Perseus Project (on ancient Greek culture at Harvard University) that have paths that can be saved for later use. Shneiderman and Kearsley (1989) contended that reversibility (being able to retrace steps and return to previous screens) is important to reduce disorientation.

Horton (1994) claimed that carefully chosen icons accompanied by short word labels outperform controls marked only by an icon or a word label, not both. Tolhurst (1993) recommended the use of a friendly guide that could be activated by clicking on an omnipresent icon for the guide. The guide could then make navigation suggestions to the user. Oren, Salomon, Kreitman, and Don (1990) showed a preference for what they called the "guides metaphor" over the "navigation metaphor" for helping users make navigational choices, even though they found that users sometimes confused the navigation advice given by guides with the content stories provided by other entities that also looked like navigational guides. Kappe, Maurer, and Sherbakov (1993) stated that since typical solutions that work well on small systems fail completely when applied to large systems, navigation must be extended by adding hierarchical organization of related material, guided tours through the information prepared by content experts, and advanced database query capabilities.

Should Hypermaps Be Provided?

Edwards and Hardman (1989) identified two principal advantages to having a survey-type cognitive map of any environment, be it a city or a database. First, there is the opportunity to visualize and then to utilize short cuts to reach desired locations. Second, for users who become distracted or lost *en route* to a specific goal, there is a far greater chance that they can regain their bearings and reach their intended destination if they have a spatial cognitive map of the environment. Kelly (1993) cautioned that navigational aids such as maps based on spatial analogies or metaphors may be appropriate for spatial navigation, but not for conceptual navigation.

Sellen and Nicol (1990) gave two other rationales for maps. They claimed that making mental navigational models explicit within hypermedia helps reduce the cognitive load for users, who would no longer have to rely on their memories to tell them where they are. In addition, a map can form the basis for a mental model of how to travel from one point to another in the database without having to keep in mind a set of procedures for navigation. Sellen and Nicol said that the type of map depends on the nature and structure of the application. In a file management database, for example, the map might display the hierarchical location of a file within a folder structure. However, maps could also take the appearance of you-are-here maps found in public buildings.

Tolhurst (1992) suggested that graphic environmental maps based on some concept (metaphor or mimesis) familiar to the user would be a useful navigational aid. For example, a learner studying human digestion could be presented with a diagram of a body with the various parts of the digestive system in view. By clicking with a mouse, users could choose body parts and reveal linked information about that part of the digestive system. At any point in the investigation of digestion, users could return to the body diagram (map) to reorient themselves if necessary.

Shneiderman and Kearsley (1989) pointed out that whereas the table of contents reveals a book's structure and content, it is not automatically apparent in hypermedia applications what information is available, how it is structured, and where the user is now. For hypermedia applications, they advised that a hierarchical view of structure and content be displayed by means of a dedicated area of the screen (which of course is only possible in a database with hierarchical structure). Locatis et al. (1989) as well as Shneiderman and Kearsley advocated having a "fish eye" view capability which allows users to see "nearby" nodes. Rada (1995) claimed that "hierarchical or fisheye views help users get a sense of the overall information landscape" (p.26).

A number of authors have recommended some type of overall structure maps for navigational purposes (Conklin, 1987; Gay & Mazur, 1991; Gygi, 1990; Litchfield, 1993; Locatis et al., 1989; Parunak, 1989; Tolhurst, 1992). Parunak (1989) claimed that useful maps could be defined even in large hypermedia systems as long as what he called the "topology," the system of links, was appropriate.

However, Landow (1990) declared that global maps do not work for any but the smallest of hypermedia databases. Landow drew this conclusion from his work with Intermedia (a hypermedia application generator originated at Brown University where Landow worked). Landow held that navigation is not a major problem in Intermedia since system features allow users to locate and travel to any information in the database by full text searches, folders, links, web views, and menus of link choices. He stated that in Intermedia users always know what documents "surround" the one being read through the use of a local tracking map (the web view) and that users can always travel to an overview document that helps reorient them.

Stanton et al. (1992) conducted a study with one hypothesis: "The presence of a spatial map will improve navigation and support cognitive map formation" (p. 433). The study was conducted using a relatively small hypertext environment with 42 screens. The study used local (fish eye) maps. Contrary to other studies, Stanton et al. found that the presence of maps resulted in poorer performance. In addition, participants using maps reported a perception that they had significantly less control over the information in the database than that reported by non-map participants. The non-map participants also performed significantly better than the map participants on their ability to classify the screens on a cognitive map task. Stanton et al. concluded that map aids may reduce the need for or interfere with learners' actively constructing their own cognitive maps — that it is wrong to assume that a map will always aid performance.

What Is the Proper Balance between Links and Nodes?

Glushko (1989) claimed that excessive linking causes serious problems of disorientation and cognitive overload for the user because it destroys most of the structural and contextual cues that users rely on for navigation. Although he stated that several researchers are working on creating new hypertext linking structures, he stated the opinion that limiting the links in the first place was a more practical solution. Langston and Graesser (1993) described one such system with a Point and Query interface where navigation is accomplished by combining a list of subjects with a list of questions. They claimed that users benefit from the "internodal coherence" (p. 357) that results from following such question trails.

McAleese (1989) described the "net" metaphor for hypertext linkages. He explained that in a "true network system" (p. 14) any given node is at most one link away from any other node, and that no node is more important than any other node. He termed network systems the ideal solution for understanding the linkages in hypertext. However, he stated that structuring, constraining the user's access to other nodes, was important if the system browser was to provide the user with scaffolding for purposeful navigation. Conklin (1987) envisioned users navigating databases via three modes: by using links, by searching for keywords (objects with certain attributes such as strings of characters or images), and by using a browser that displays the network graphically. Hence, Conklin's description of hypermedia supported both the network system approach and the structured or constrained approach to navigation.

What Level of Learner Control Is Advisable?

Litchfield (1993) defined learner control to be the amount of latitude a learner has over the direction and depth of investigation. She claimed that for some users too much learner control is counterproductive, and that many users choose to return to programs where the content is program controlled. On the other hand, Shuman (1998) asserted that hypermedia empowers users by giving them control — control that allows users to individualize their own instruction to address different learning styles and needs. Bernstein (1991) saw both sides of the issue. On the one hand, he said hypermedia authors could acknowledge learners' active participation by giving them a richer web of links to traverse. However, he said an author could reduce the apparent complexity of the content for learners by imposing a clear and limited organizational scheme on an otherwise complex system.

Shneiderman and Kearsley (1989) reported that some interface researchers hold the opinion that building sophisticated "intelligent agents" undermines the users' sense of control and their feelings of accomplishment. Instead of building intelligence into the machine, the designers seek to enhance learner control by providing navigation tools for browsing, searching, and employing filters. Laurel (1990) countered this argument by saying that a good agent "will do what I want, tell me all I want to know about what it's doing, and give me back the reins when I desire" (p. 357). She proposed that only users who wanted to use agents should have them, and those who do not should have other choices.

Jonassen and Grabinger (1990) maintained that learner control permits the user to direct the sequence of instruction in such a way that the user obtains the appropriate type and amount of support. Instead of the instruction directing learners, learners should be empowered to make judicious choices to adapt the instruction to their own needs and interests. For Jonassen and Grabinger, this notion is supported by the theory that learners know what is best for them and that learners in control of instruction will invest more mental effort in their learning. Nevertheless, Jonassen and Grabinger admitted that research does not support this sentiment, especially for average and below-average learners — that learners do not make the best decisions when given unrestricted control.

Learning Theories Implemented in Hypermedia Applications

Some authors have associated the type of navigation in various systems with particular learning theories. Horney (1993) said that the network system approach, where each node is linked to every other node, supports constructivist learning. By contrast, hypermedia applications that exhibit linear or severely constrained link structures could be construed to be behaviorist in philosophy. Traditional cognitive theories would then be associated with applications situated between the two extremes. Under this scheme, behaviorists would favor linear navigation with limited learner control and no maps. Constructivists would favor unrestricted navigation with high learner control and hypermaps that would allow users to jump easily from place to place in the database. Convinced that individuals are more than flesh-and-blood, stimulus-response machines and armed with the results of studies that show unrestricted travel between nodes to be disorienting for all but the most gifted of learners, traditional cognitivists would chart a central course with many opportunities for non-linear exploration. Cognitivists would choose to have learner control high but not so high that it creates disorientation and distraction. Cognitivists would also take advantage of cognitivist devices like maps and metaphors to supply navigation clues for users. Most hypermedia applications fall under the cognitivist rubric. Readers may find that the approaches used and conclusions drawn about hypermedia environments are best understood by considering the associated learning theories that the authors advocate.

Research Questions

The issues discussed above suggest the following research questions:

1. What is the appropriate screen layout for navigation in a hypermedia database?
    a. Should navigation controls reside in dedicated areas or be available only when requested by users?
    b. What are the most effective representations for navigation controls? For example, should navigation controls be marked by icons, by names, or both?
    c. Should navigation controls overlap other controls on the screen?
2. What is the appropriate use of color in a hypermedia database?
    a. Should special colors be used to allow users to differentiate between certain types of navigation controls ?
    b. Should special colors be used to allow users to differentiate between various locations in the database?
3. What is the appropriate use of hypermaps or other locational devices?
    a. Should users be provided with hypermaps or other devices so that they have a sense of where they are or have been?
    b. Should hypermaps or other location-indicating devices also allow users to jump from place to place in the hypermedia database?
    c. Should some device be provided to tell users how "deep" they are in the database?
4. What is the appropriate degree of consistency to use in the design of navigation?
    a. Should the functions of icons be consistent throughout the database?
    b. Should controls be consistent as to location on the screen, what they look like, and what happens when clicked?

5. What are the appropriate types of pathways for transit through a hypermedia database?
    a. To what extent should users be able to retrace their steps or save paths made through the database?
    b. How easy should it be for users to access, alter, or digress from previously stored paths through the database?
6. What is the appropriate level of user control in a hypermedia database?
    a. To what extent should expert users be able to move through the database quickly with fewer steps or key strokes than would be prudent for novice users?
    b. Is it better to have a few long pull-down menus or several shorter ones?
    c. Should designers eliminate controls that most users are not expected to use (that may be accessed in some alternate manner by those who need them)?
    d. To what extent should users be able to wander through the database to see what is available (the way that one might browse through a set of encyclopedias)?
    e. What mechanisms should designers provide so that users can determine with some certainty whether or not a particular piece of information is present?
7. What is the appropriate use of a help function in a hypermedia database?
    a. To what extent should the help function be sensitive to the context when help is sought by users?
    b. To what extent should the help function anticipate problems that users may have in using the database and suggest solutions?
    c. To what extent should the help function suggest strategies for using the database?
8. What is the appropriate relationship between the learning styles of users and the navigational controls available in a hypermedia database?

Methodology for Proposed Research on Hypermedia Navigation

As a strategy for resolving the research questions listed above, one does not necessarily need to create a brand new hypermedia database. One can examine whether the hypermedia databases created in the past, often at great expense, can be significantly improved by introducing those navigational features that are currently being advocated by hypermedia designers. One such database is the Perseus Project. Hypermedia applications were first developed for personal computers some ten years ago (Hall, Davis, & Hutchings, 1996). The first version of the Perseus hypermedia database embodied the design principles employed at that time. The second and most recent version of Perseus released in 1996 still retains the original navigational design structure proposed in 1988. Since Perseus is a hierarchical database, it is possible to alter the overall navigational superstructure in order to test various hypotheses about navigational design without changing the vast majority of the information stored in the database.

The Perseus Project

The Perseus Project is an ambitious undertaking begun in the Classics Department of Harvard University. It is devoted to the creation of a massive interactive hypermedia application, called "Perseus," on ancient Greek culture. According to Crane and Mylonas in their 1988 article: "The Perseus Project is developing interactive, computer-based materials on Greek Civilization. These are designed to support learners, instructors, and researchers as they explore this complex subject" (p. 25). The initial four-year funding proposal for Perseus to the Annenberg/CPB Project, Apple Computer, and Harvard University dated May 24, 1988, was for $3,390,541, with the final project cost between $4 and $5 million (Hughes, 1988). The literature about hypermedia applications includes frequent favorable references to Perseus. It has been praised in journal articles as a model for hypermedia development. Hughes called the Perseus Project "today's most ambitious, intriguing, and promising application of computer technology to academic instruction and research in the liberal arts" (1988, p. 1). In her article about evaluating Perseus, Neuman asserted: "The project is innovative in its development process, its technological sophistication, its range of potential applications, and its intended outcomes" (1991, p. 239). Since its carefully developed design epitomizes the navigational controls typical of hypermedia databases created over ten years ago (See Figures 1 and 2 for examples), it is a fit subject for the intended research.

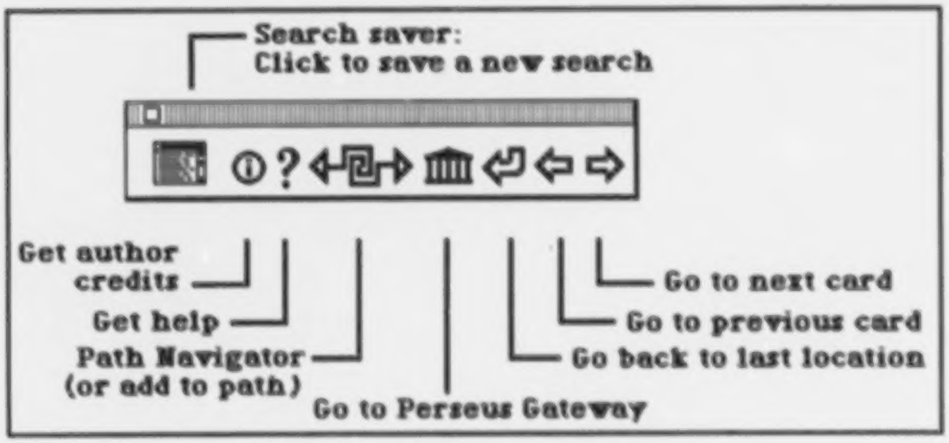
Search saver:
Click to save a new search
Get author credits
Get help
Path Navigator (or add to path)
Go to Perseus Gateway
Go back to last location
Go to previous card
Go to next card

Figure 1. The Floating Perseus Navigator in Perseus 2.0

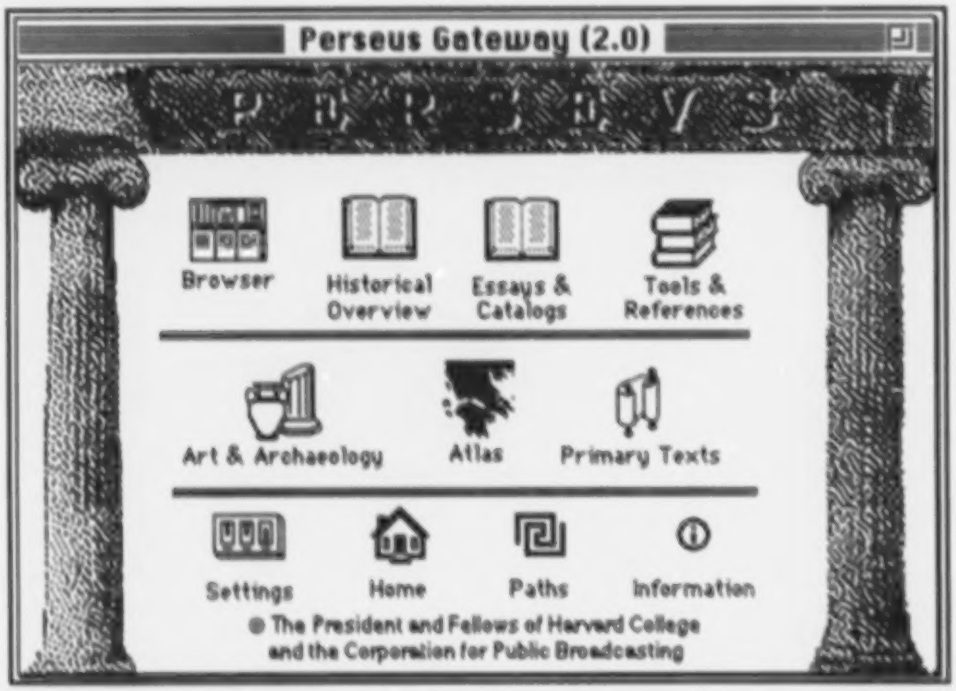
Perseus Gateway (2.0)
PERSEVS
Browser
Historical Overview
Essays & Catalogs
Tools & References
Art & Archaeology
Atlas
Primary Texts
Settings
Home
Paths
Information
© The President and Fellows of Harvard College and the Corporation for Public Broadcasting

Figure 2. The Perseus Gateway

Previous Evaluation Results

Marchionini and Crane (1994) reported the results of a three-year evaluation of Perseus in a lengthy article in the *ACM Transactions on Information Systems*. The evaluation examined a number of instructional design issues. However, the evaluation was summative, not formative, in nature. Also, the evaluation was qualitative (naturalistic inquiry), not quantitative. Rather than suggest changes to the Perseus application, Marchionini and Crane suggested how users could be better prepared or trained to use Perseus more effectively.

> The evaluation effort described here involves a complex system (Perseus) based upon a new technology (hypermedia) applied to abstract goals (finding relevant information, learning how to think critically). The overall evaluation effort aims to inform general hypermedia application design, develop human-computer interaction and information-seeking behavior theories, and add to our understanding of learning and teaching. (Marchionini and Crane, 1994, p. 6)

The Proposed Research Study

Testing the long list of research questions given above is a daunting task by anyone's standards. Even if only two alternative hypotheses are considered for each of the eight categories of research questions above, sixty-four test groups would be required to consider all possible interactions between the various treatments. Hence, the proposed study will concentrate on two treatments: decentralized dedicated areas for navigational controls vs. the centralized menu driven design of the original Perseus; and unique, named iconic representations of navigational controls vs. the representations in the original Perseus.

Hence, there will be four test groups in this two by two design: (a) the control group, which will use Perseus in its original form, (b) a group tested with Perseus modified to have dedicated areas for navigational controls, (c) a group using Perseus modified to have unique named iconic representations for navigational control, and (d) a group using Perseus modified to have both dedicated areas and unique named icons (See Figure 3). Participants for each group will be randomly selected from the target population, college-level students with some hypermedia experience.

Participants will be given a pretest and posttest to measure comprehension. They will be tested individually using the speak-aloud protocol while they are using the Perseus hypermedia database. Each session will be videotaped to preserve a record of each participant's performance (verbal and physical) using the version of Perseus appropriate to the designated group for that individual. The testing will produce two types of data: (1) measurements for comprehension by use of pencil and paper testing before and after each session, and (2) measurements of how long it takes to accomplish specified navigational tasks. The sessions themselves will be "scavenger hunts" through the Perseus database for the answers to a set of approximately ten questions. The sessions are called scavenger hunts because the questions may be answered in any order, thus, simulating a hypermedia learning environment where one might serendipitously stumble upon one answer while actually looking for another.

Future Directions

Assuming that the research study reveals a significant difference between the treatment groups and the control group in the proposed study, the authors intend to continue testing the various navigational research questions given above. The ultimate goal would be to develop a navigational system for Perseus that incorporates all the navigational features that produced significant improvement in comprehension and efficient usage (speed).

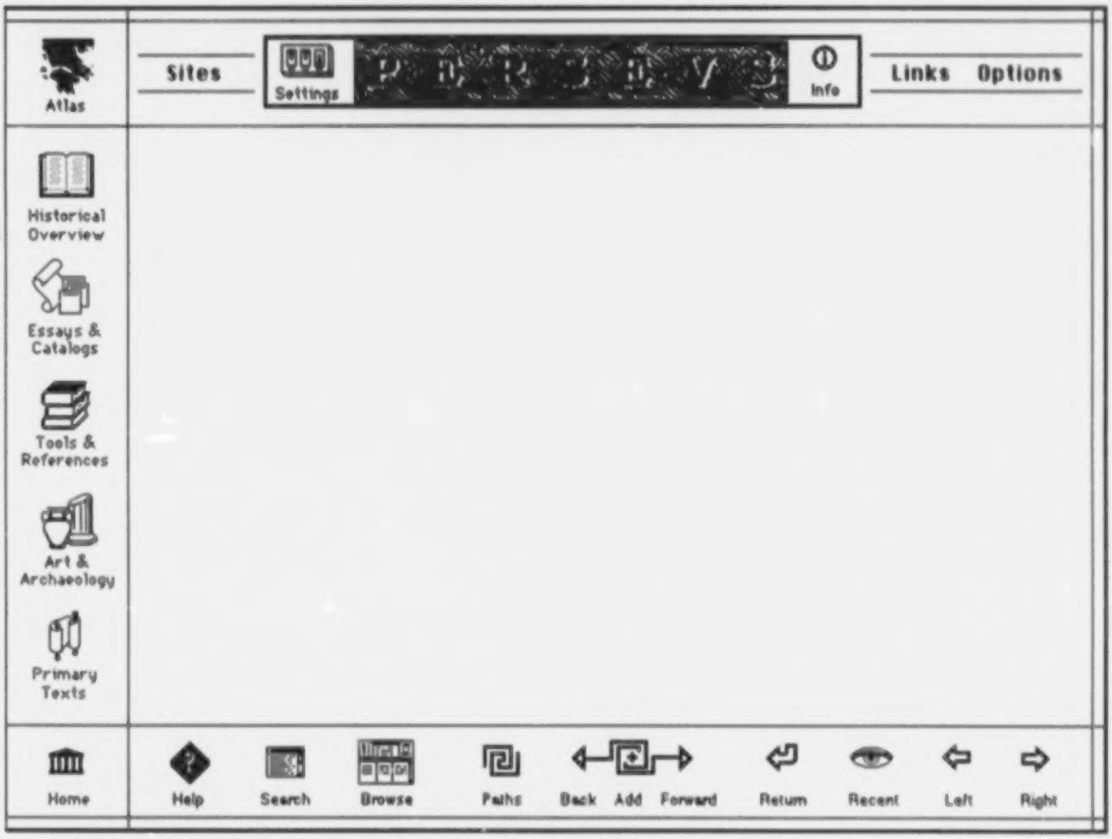
Atlas
Sites
Settings
Info
Links
Options
Historical Overview
Essays & Catalogs
Tools & References
Art & Archaeology
Primary Texts
Home
Help
Search
Browse
Paths
Back
Add
Forward
Return
Recent
Left
Right

Figure 3. Suggested Decentralized Navigational Design to Replace the Perseus Gateway

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Technology: Creating a Community of Thinkers

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Abstract

Building a community of thinkers is a goal for education. In a world in which technology provides a means to communicate quickly and efficiently, educators need to develop models for the use of technology as an integral part of building an environment for teachers to thinking critically and creatively.

Technology was used to help create a community of thinkers in the Social Studies in the Elementary School course at the University of Missouri-Columbia. During the preservice course, students used technology to write and think critically about social studies education. Through on-line reflective journals, electronic mail, a class listerv, a newsgroup, and the Internet, students incorporated technology into their research, writing, reflecting and reacting to social studies in the elementary school. Technology supported a forum for open communication between students and instructors and enriched the learning environment. By building technology into the pedagogy of the course, it provided a means for building a community of thinkers.

To create a community of thinkers in the classroom everyone should be responsible of creating ideas and sharing knowledge. Students were the best advocated for promoting the integration of technology into learning process and they can be held responsible to the group for participating in the thinking, writing and technology. It was the instructor's responsibility to determine when the quality of the task would be enhanced with the use of technology. The integration of technology into the classroom provided the students with more time for quality reflection and made better use of classtime.

Technology: Creating a Community of Thinkers

A challenge of colleges and universities for the 21st century is the integration of technology into the learning environment (Barksdale 1996, Jonassen 1995, Snadell, Stewart & Stewart 1996). By incorporating technology into the college classroom the students expand their technological literacy and expand the learning environment beyond the classroom walls. Technology is not only a tool for receiving and disseminating ideas, technology can be a means for articulating ideas, support for differing viewpoints, and responding in thoughtful and creative ways. The use of telecommunication bonds the participants in interdependence, congruence of the task and provides a forum for reflection (Thomas, Clift, & Sugimoto 1996)

Technology must be a integral part of the pedagogy of teaching and learning environment. A meaningful learning environment includes the following seven qualities active, constructive, collaborative, conversational, intentional, contextualized, and reflective (Jonassen 1995) and technology can be a partner in meaningful learning. Educators need to find ways to promote a constructivist learning environment and a community of learners, in which students are active in selecting what to learn, processing new knowledge, and assessing his/her progress and using technology as a means to support the environment

The paper will include how the social studies in the elementary school course developed a community of learners and incorporated technology. Several methods for using technology to facilitate thinking in the social studies education course were (1) listserv, (2) electronic mail, (3) a newsgroup, (4) on-line reflective journals, (5) in class on-line assignments, and (6) implementation of technology into elementary schools lessons.

Setting

Since the 1996 fall semester, there have been over 180 students in the Social Studies in the Elementary School course. For course assignments, most of the students used the Macintosh or PC computers in the Reflector, the College of Education computer laboratory. As students of the university, they have free access to electronic mail, the Internet, course newsgroup and a class listserv. The instructors provided an introduction to the use of each of the forms of communication that is used in the course. We provide the e-mail address of each individual in the course, the class newsgroup and listserv addresses, and the home page for course.

Social Studies in the Elementary School is a required three semester hour course for the undergraduate elementary teacher education students at the University of Missouri-Columbia. All course information is posted on the course home page: http://www.coe.missouri.edu/~esse. The course is technology based and meets the university's writing intensive requirements. Within the writing assignments for the course, students are required to write drafts of their work, revise and resubmit work, incorporate critical thinking into writing and write more than 20 pages during the term. The course is scheduled for 50 minutes on Monday, Wednesday and Friday and the Friday sessions are conducted in a computer laboratory.

Technology Related Assignments

Assignments	Technology
In-class Group Work	Listserv
Internet Exploration	Internet
Software Review	CD Roms
Discussion Groups on Issues	Listserv
Reflective Journals	On-line form
Field Experiences	Varied
Article Review	Newsgroup
Concept Maps	PIVIT
Graphic Design	Photo Shop

*Excluding word processing for writing.

The environment of the course is established with the focus on developing a community of thinkers. An environment that incorporates computers needs to have a pedagogical style which utilities the instructor as a facilitator and a collaborative style of instruction (Goodson & Mangan 1991). The instructor is a facilitator for learning and the students work as a community of learners by completing the assignments as a team of preservice teachers. The class meets in a traditional classroom, a computer laboratory and in student selected locations.

In on-line reflective journals the students have made comments and reactions to the course design and the role of technology in the development of preservice teachers.

> I keep plugging away. At least now I don't find it scary, I find it challenging.
>
> I'm glad we had a chance to do this--it was learning through discovery!

Electronic Mail

Electronic mail (e-mail) is defined as an electronic communication system that enables users to share information about topics of common interest (Vockell and Brown 1992). A subject of joint interest to all students are class assignments. Using e-mail, the instructor possesses the ability to inform all students of upcoming class events.

A typical collegiate class possesses many academic deadlines. Assignment are due at a certain time and student stress rates elevate as completion dates draw near. When the students are feeling anxious about their work the instructor must assume the role of a motivator. Students received these messages:

> You should be very proud of your work on the clusters this term. I hope you can take advantage of your work when you student teach.
>
> E-mail is a form of communication in which we can learn from each other.

Electronic mail allows students "to send messages to individual colleagues, groups" (Buckley 1995) or the entire class at one time. One student wrote to the collective group of elementary social studies students:

> My group's cluster project is going all right. We are doing endangered species, and it is proving an easy topic to find information about. Good luck to anyone that is presenting their project in the next week.

The implementing of technology, in a class curriculum, can cause fear for many students. E-mail can be used to ease these feelings of inadequacy. By employing e-mail students "vented" their frustrations concerning technology usage.

> I didn't know how to use the Internet before this class. I was almost terrified when it came to using computers.

> The one thing I would like to mention is that I'm not afraid of technology and I am confident that I can learn.

As the students gained confidence in their ability to use technology as a communication tool, e-mail responses reflected the students new found confidence:

> As an elementary social studies teacher I will bring technology into my classroom by making it available to students and using it in planning and carrying out lessons.

> I use e-mail a lot more often than I used to. I also gained great ideas from classmates because of the listserv.

> It was very beneficial to use technology in order to get used to it before stepping into the classroom. It has prepared me to use technology in the future and I will be more able to apply my skills.

Electronic mail enhances the instructor's ability to form a community of learners. Electronic mail encourages opportunities for meaningful reflection and allows the student and instructor to observe the thinking and construction of the meaning (McIntrye and Tlusty 1995). When students have the motivation to use and the knowledge to operate e-mail, a classroom of strangers becomes a grouping colleagues. In this scenario, SHARED information is the power that builds professional unity.

Discussion Lists

Establishing a community of learners was accomplished in the implementing of a class listserv. The listserv, designed as a virtual forum (Wild 1996) for class participation, facilitated the transfer of ideas between students and instructors. Involvement in listserv activities was established by the organizational framework of the listserv.

The class subscribed to the listserv following a classroom discussion concerning the educational possibilities of listserv usage in elementary school social studies classes. Once the class had joined the listserv, the class was divided into thirds. Each student was assigned a number one, two or three. Correspondingly, the three instructors of the class were assigned a number group to cultivate. On a rotating weekly basis an instructor posed a question concerned with some aspect of elementary school social studies or classroom teaching situation. After reading the listserv question the members of the assigned group would respond to the question. All members of the class could respond to the query of the instructor. No limit on response length was determined by the instructors or the students. The students received questions on Monday and were expected to respond to the questions by Friday of that same week. A sample question the students responded to dealt with student relations in the classroom.

> You are sitting at your classroom desk. Several students are making belittling comments toward another student. The students feelings are hurt. The student catches your eye and beseeches for help. What course of action do you follow to change this negative classroom situation?

Specific topics discussed on the class listserv varied. In particular, holidays were a popular discussion topic. The celebration of Halloween, Christmas and Easter elicited pointed responses among the students. One student wrote about observing Christmas holiday in public schools:

> The only holidays I remember learning about in elementary school are Thanksgiving and Christmas. It didn't bother me that we were learning about them because my family celebrates those holidays. Since there are so many diverse backgrounds in the classroom, teaching holidays can be tricky and touchy.

A student's ability to express personal beliefs and thoughts, with anonymity, is one of the positive aspects of the listserv. When asked to give input upon "everyday" classroom situations, e-mail allowed the college students to express their feelings and supply feedback to the instructor.

> On Divorce: The topic of divorce is one that is very important to me, being a child in a single parent home. I remember in elementary school we had an hour or two a month where children of divorce could go and talk about their needs and concerns.

> On Death in the Family: When dealing with the death of a parent I would first invite that student to let me know how he or she is feeling. I would share the story of when my mother died and how I felt and still do.

> On Medical Problems: As someone with a medical problem I can share my experience on how it was for me. I was diagnosed with a heart condition at a very early age. I was never able to participate in activities that my classmates did and they never told me why.

The disadvantages of constructing a listserv for the class were few. The largest concern was the sheer bulk of correspondence (Pearson 1996). Typically an instructor or a student could respond to one hundred and fifty e-mail messages during the semester. The advantages the listserv presents for a class outweighs the concerns a listserv presents for instructors and students. Long and complex conversations develop on listservs, as students explore their developing understandings of both content and pedagogy (Piburn & Middleton 1997). Pearson (1996) states listservs establish the framework for networking and scholarly cooperation, knowledge acquisition a sense of communion and an opportunity to keep pace with innovation. Most important, students find that listservs are fun; and they participate in them with enthusiasm (Pearson 1996).

The Newsgroup

Newsgroups can be more than a place to receive and disseminate information. Students can select what messages are worthy of their response. The responses can be a dialogue of diverse points of view and creative and critical responses.

During the first week of the semester, the students subscribe to a class newsgroup where messages are posted. The newsgroup is attached to the university electronic communication lines so a student can receive e-mail and newsgroup messages on the same system.

Each student selects two exemplary articles on current issues in elementary school social studies such as religion, integration, law related education, holidays, the environment, or economics. The student should review journals such as Social Education, The Social Studies or Social Studies & the Young Learner. The article review consist of an APA reference for article, a paragraph summary of the article and a reaction to the article with discussion questions and the students name. The students are given two weeks to submit each article review on a separate message to the newsgroup.

After everyone has submitted the articles reviews on-line, each student selects two article to read, review and respond to on-line. The response should include the name of the article, the students name and responses to the questions, new ideas, or a continuation of the review. The students reply to the message and latest responses become the last messages on the newsgroup list. The students have two weeks to complete their article responses.

This assignment was designed to incorporate the qualities of meaningful learning (Jonassen 1995) and technology was used to support experiences that engage students in purposeful learning. The newsgroup provided a learning environment for students to be actively engaged, communicate and collaborate with peers, construct knowledge and reflect on ideas and issues in social studies education. The assignment required the students to construct new knowledge from the information found in professional social studies journals and to actively communication their ideas and reactions on the article to their peers. The article reactions and responses allowed students to communicate ideas to the group and reflect on the topic. By having the article reviews on the newsgroup, the students read and reflected on a wide range of current journal article and topics that due to time could not be discussed during classtime or distributed in paper form. One student said: "I really liked having things posted in the newsgroup and on the e-mail. I could check them anytime of the day or night."

On-line Reflective Journals

Electronic journal writing models behavior that engages the computer as a intellectual partner in facilitating a specific task (Anders & Brooks 1994). The task can be to write about the topics for the course, the assignments, issues in the field, concerns about the course, reflect on the past and make connections to the future. By writing in the journals the students are thinking critically, reflecting and reacting. The students use the reflective journal to actively construct new knowledge.

The students complete a weekly on-line weekly reflective journal http://www.coe.missouri.edu/~esse/reflective.html. The purpose of the journal is to reflect on an aspect of social studies education or the content of the course during the week. The students select the topic and focus of the reflective journal entries. Each week the students write a response to five open ended statements.

- What I learned...........
- What I would like to learn............
- How will I use what I have learned in my future classroom.......
- Goals for the future ....
- Comments/suggestions............

Upon completing the form, the student submits his/her response. The entries for each student are filled in an on-line data base that contained a running log of his/her weekly responses. The journal entries can be reviewed by the instructor or the students to reflect on the course. The instructor read the journals on a weekly bases and responded to individuals by e-mail, or to the group as a listserv message or as an in class announcement. The students can review weekly journals entries.

TABLE 1 Sample Summary of Reflective Journals for Fall 1997

Date	Focus	Summary/Example
Sept. 16-20	Procedural	Internet
Oct. 7-11	Pedagogy	Field Experience
Oct. 21-25	Pedagogy	CD ROMs
Nov. 4-8	Diverse	Unit Project
Dec. 2-6	Pedagogy	Semester Closure

We found several positive aspects of using an on-line reflective journal to support a meaningful environment and reflective learning. For reflection, the journals provide the students with an opportunity to articulate what they learned and reflect on their knowledge and skills. Because the reflective journal was on-line, the students select where and when to complete the journal, the students use as much time as needed to complete the journal and extend the time and effort spend on the reflection. The on-line communication allows individuals that are reserved to express ideas and students to take risk more than he/she might in class.

The students submit the weekly forms and at the end of the term submit a three questions about the use of technology in the course. In the future we will have students write a summative reflective paper in which the student has the opportunity to review the weekly reflective journals and summarize their progress during the term and set goals for the future.

In Class On-line Assignments

Throughout the semester, the students develop a list of goals and objectives for what is taught in social studies at each grade level. The students use the National Council for the Social Studies Standards (1994), the Missouri Show Me Standards, the Columbia School guidelines, college and elementary school textbooks to research what is included in the elementary social studies curriculum. These documents and others are used to develop the list of grade level guidelines. As the term progresses, the students use the list of goals and objectives for developing lessons and units.

In the second week of the semester, the students form a committee of four to research the scope and sequence for social studies at a specific grade level. During a class period, the groups develop the initial list of ideas and submit their ideas to the listserv. The list of ideas is the brainstorming of concepts and skills at a grade level.

The students reflect and react to the list throughout the semester and the listserv message for a grade level is revised and updated as new ideas are discussed or presented. The list of goals becomes more defined and specific as the students learn new concepts.

By having technology integrated into this assignment the students can research, write, and reflect on the grade level objectives throughout the term. It is an opportunity for students to construct new knowledge as needed and to share the knowledge in printed form to their peers as soon as it is completed. The resources for the assignment are the current materials that they will need to use as teachers. The assignment is student focused and the list of ideas is distributed by the students and retrieved as needed by the students. The value of this assignment is that the ideas are generated by students.

By using the listserv to share the brainstorming of small groups, technology allows students to receive the ideas from their peers in a quick and efficient manner. Messages in a listserv can be revised and new ideas can be added as time passes. The instructor doesn't have to develop a new handout or present new information. It is exciting when learning about a topic can be expanded over time and new messages submitted to the listserv can include thoughtful and creative reflections and reactions. A copy of work during class can be provided to each student instead of being left on chart paper or the chalk board to be destroyed.

I continue to look for methods to use technology during class time for share information during small group work. I am considering using technology to brainstorm a topic, discussion an issue or peer reviews of papers. It is exciting to consider the options of how students can be given a task on the listserv, work in small groups with materials on reserve in a resource center, and disseminate the information. The instructor becomes the facilitator. This is a small scale example of distant learning in a traditional setting.

Technology in Elementary Schools

Preservice teachers encounter many challenges when technology based instruction is employed the classroom. How the preservice teacher responds to these obstacles determines if technology is an integral part of classroom instruction.

A major concern, for the preservice teacher, is the existence of a positive technological culture in the school. For successful technology based instruction in schools, a positive (technological) culture in the school community (Lee 1996) needs to exist. Intensive technological inservice programs and sufficient technical support is needed to provide technology based instruction. Teaching in a supportive technological environment is important but basic educational needs must be addressed in the formation of a positive technological school culture.

How many computers are available for classroom instruction is important to the preservice teacher. The preservice teacher must know how many computers are available for instruction. Will classroom technological instruction be possible or will planned excursions to a computer lab be needed?

Another challenge for preservice teachers is knowing what technology is available for classroom instruction. Are CD-ROMS available at the school's media center? Does the school possess the capability for internal school communication and, thus, increase professional dialogue among teachers (Buckley 1995) and students (e-mail)? Is the school connected to the World Wide Web (Internet)?

Developing a community of learners in a teacher education classroom is key to modeling how the preservice student will develop a community of learners in elementary schools (Bell 1995). Preservice teachers need to know and increase their own technological knowledge. To this end, does the school district/building provide inservice training related to technological classroom instruction? Is adequate technical support provided by the school to solve dilemmas which develop in the transmission of technological based instruction? If the Internet "goes down" during an instructional unit, who will place the lesson "on-line"? Though challenges do exist in the implementation of technological based instruction, a developed plan of attack should lessen the anxiety of instituting a curriculum based on technological instruction.

In developing a lesson plan, preservice teachers are introduced to many planning strategies. A commonly used planning scheme starts with searching available databases with search engines. Numerous commercially based search engines are available. Yahoo, Alta Vista and Lycos are three of many search engines used in planning. Information garnered by the search engines is then utilized to search the World Wide Web (Internet). The Internet provides the preservice teacher a multitude of information sites, many of which possess interactive components, that are applicable to classroom instruction. Through class listservs, e-mail and newsgroups preservice teachers share their Internet discoveries with classmates. This promotes professional discourse among the preservice teachers. Technology available for the presentation of information takes many forms. PowerPoint, photoshop and pagemaker are a few of the vehicles employed to bring technologically based instruction to the classroom. Coupled with informational gathering knowledge, preservice teachers are exposed to the many computer-based methods of teaching.

Simulations and games are frequently used methods of instruction in teaching social studies. Simulations allow students to engage in activities that would otherwise be too expensive, dangerous or impractical to conduct, in the classroom (Berson 1996). An example of a social studies simulation study is Rivertown Simulation. This simulation is concerned with the rebuilding of a city located on a river (www.emich.edu/public/geo/rtownintro.html). As mentioned earlier, use of the Internet is a popular technological tool in the classroom. In the technological world of the Internet, this tool allows for virtual exploration of numerous topics. The Internet empowers the classroom teacher to transport the learner to the far reaches of the world. Insiant visual access with the Internet combined with instant written communication abilities provides the student and the preservice teacher an endless opportunity of knowledge constructing possibilities.

> I wish my teachers in elem. school has used integrated themes like we are writing -social studies would have been a lot more fun! I used to hate it and am learning to like it again.
>
> I guess when I think about student teaching, I wonder if I can do all the work that goes into a unit and be teaching at the same time.

Conclusions

Research continues to be lacking on how to use technology as a tool for teaching social studies (Berson 1996). Instructors and preservice students are challenged to develop methods for incorporating technology that facilitates a community of thinkers. As instructors and preservice students make the use of technology an integrated component of their daily life and are proficient user of technology, then educators can discover new methods for combining thinking and technology. To use higher level thinking skills and to use technology take time and require advanced skills, educators must consider if the investment is worth the return.

Each time technology is integrated into the course there are new challenges and successes. Remember that the instructor is not the only teacher in the classroom, students are excellent in providing expertise in technology. Sometimes the simple task can be the most rewarding, such as when students get "empowered" when they learn to cut and paste to other location besides word processing documents. We have learned that it is important to preassess the students skills level in using each form of technology and adjust our instruction on the use of technology accordingly. We recommend the instructor select one class assignment or task each term and determine if technology can be used to enhance the quality of the learning process.

The shift in the pedagogical infusion of technology is key to encouraging problem solving and inquiry driven approaches (Bulter & Clouse 1994). The use of technology in the course begins with the instructor initiated ideas, expectations and assignments. As the semester progressed the students used technology to form a community of learners by establishing common goals, working in groups, sharing resources, and collaborating on projects. When students become vested in the writing and using technology then a community of thinkers is formed and all groups do not reach this level of responsibility. The level of student involvement and ownership in the process varies each term.

One students reflective journal at the end of the fall 1996 term summarized the techniques used in the course for providing preservice social studies teachers with the skills to use technology and create a community of thinkers.

> "It has been beneficial to me and I have learned many things including how to research and put together a unit. I felt that I learned a lot about teaching social studies. What I did not learn, I feel I now have the background knowledge to research on my own. I also learned much about technology in the classroom and I hope that I have the resources to use the things I learned in my own classroom."

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Analysis-Based Message Design: Rethinking Screen Design Guidelines

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Abstract

Since the 1960's computer interfaces have evolved from text-based to multimedia formats, resulting in an evolution in the research regarding interface design. This article describes the evolution of research issues from text-based interface design guidelines to more complex issues including media selection, interface design, and visual design. This research is then integrated into the Analysis-based Message Design (AMD) process. The AMD process divides the interface design process into four action steps, the fourth of which features the ABC's R' US design principles.

Introduction

Since the design of computer screens was first addressed in the 1960's, the types of features used in instructional products have not just expanded, they have exploded with new possibilities such as graphical user interfaces, hypermedia, digital video, and virtual reality. Similarly, the area of interface design research has also evolved in order to adjust for these changes.

The purpose of interface design research is to determine which factors help computer screen layouts support learning and which factors may detract from learning. The goal of this paper is to describe the genesis and development of existing interface design research and to describe a process called Analysis-based Message Design (AMD) which incorporates this research throughout its four-step process.

Print-based Design Research

Computer-assisted instruction (CAI) began in the 1960's with text-based programs such as the Stanford CAI project, the IBM 1500 CAI system, and the PLATO project (Saettler 1990, p. 456). The first interface design guidelines for the growing number of text-based CAI programs were based upon research on print-based instruction, especially M. A. Tinker's *Legibility of Print* (1963). While Tinker's work was a compilation of legibility studies on various print topics (see Table 1), his findings were the basis of a series of prescriptive guidelines for computer text (Reynolds, 1979; Rambally & Rambally, 1987; Shires & Olszak, 1992).

Table 1. Summary of Tinker's Legibility Findings and Corresponding Design Guidelines

Topic	Tinker's Findings	Design Guidelines
Text Style	• Italic type was found less legible than normal text. • Bold text used for emphasis did not decrease legibility. • Lower-case letters were more legible than all-caps.	• Avoid italic type. • Use bold text for emphasis. • Avoid using all-caps.
Text Font	• Sans serif and serif fonts were found equally legible; however, readers preferred serif fonts.	• Use serif fonts for large bodies of text.
Text Size	• Very small and very large type sizes decreased reading speed.	• Use 18pt text for headings and 12pt text for body text.
Line Spacing	• Leading had an important effect on legibility. An average leading of 2-4 points proved the most legible for most font and line length combinations.	• Double space text or skip a line between paragraphs.
Line Length	• Readers preferred moderate line lengths and ample margins.	• Leave white space in the layout.
Text Blocks	• Square blocks of text were found less desirable than regular blocks of text.	• Avoid justified text blocks.
Color Combinations	• The most legible color combinations were those with the greatest contrast between the text and the background, such as black text on a white background	• Use dark text on a light background or light text on a dark background.

Current Interface Design Research

The 1980's brought a new face to computers, the graphical user interface (GUI). While the first computers with GUI interfaces were manufactured by Xerox, they did not have national attention until Apple announced its line of GUI computers in 1984 (Cambell-Kelley & Aspry, 1996). This new interface with its multimedia capabilities presented designers with a variety of text, audio, and visual design options. As a result, print-based guidelines were supplemented by interface design research which related to text, as well as multimedia.

In the past, some designers have sought prescriptive design guidelines, lists of the "do"s and "don't"s of interface design. However, as Megarry relates, such simplistic lists of guidelines cannot adequately address the design variables in complex multimedia products (1991). Therefore, current interface design research involves a rethinking of the concept of interface design guidelines. From the 1980's until the present time, the focus has shifted to three main types of interface design research: media selection research, interface research, and visual design research.

Media Selection Research

Media selection research is based upon the assumption that certain media are more effective than others with regard to certain types of learners or content (Kozma, 1991). This research tests the effectiveness of different media under various learner, content, and delivery environment conditions. Instructional designers can use this research to guide their selection of the most effective media features to meet the conditions surrounding their instruction.

Interface Research

Interface research deals with the design and testing of human-computer interfaces (Apple, 1989; Cates, 1994; Laurel, 1990; Nielsen, 1990; & Shneiderman, 1992). It revolves around the consistency between the content, the media, the functionality, and the metaphoric theme of a multimedia product. Instructional designers can use this research to help them develop a product which supports clear and consistent interaction between the user and the computer program.

Visual Design Research

Visual design research addresses the visual principles used in interface design. These heuristics are extensions of the ancient Greek aesthetic principles of symmetry, order, emphasis, unity, and balance. These principles have been extended to also include proximity, and parsimony (Heinich, Molenda, Russell, & Smaldino, 1996; Williams, 1994; Reilly & Roach, 1986). Instructional designers can use these principles of aesthetic visual design decrease feelings of stress among learners and increase feelings of confidence and stability (Reilly & Roach, 1986, p. 39; Rambally & Rambally, 1987, p. 151).

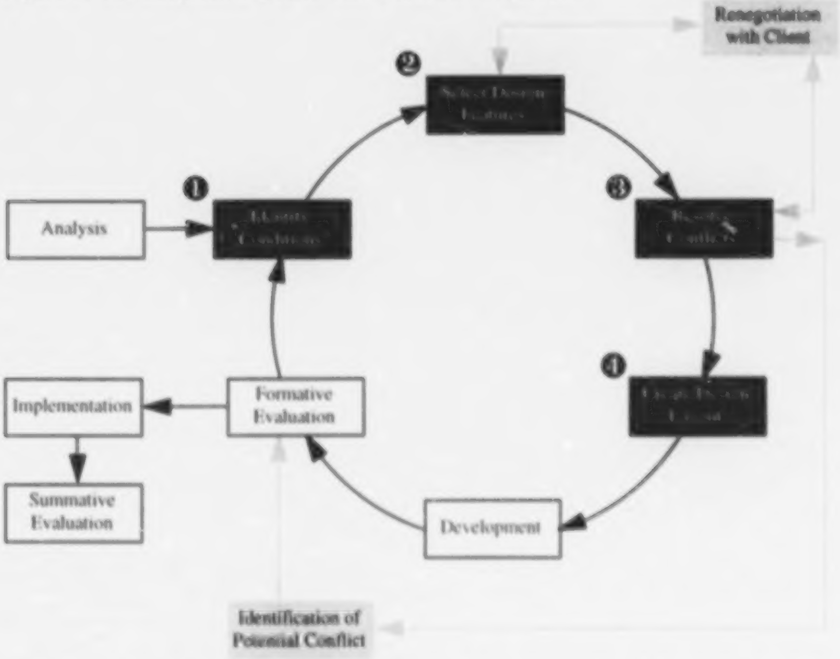
Analysis-Based Message Design Process

Computer screen message design addresses the three layers of a screen: the content layer containing the information to be learned in the form of various media features, the interface layer containing the means through which the learner interacts with the information presented (text, graphics, etc.) including the structure through which it is presented (navigation, metaphor, etc.), and the aesthetic layer which organizes the information and interface according to aesthetic principles. The AMD process reflects the way in which these three layers are designed. It addresses how the research is used in making design decisions. AMD is a process which separates the design phase of the Instructional Systems Design (ISD) model into a four-step process. During this process, the instructional design team will (1) identify conditions, (2) select appropriate design features, (3) resolve conflicts between design features, and (4) create a design layout for use in the development of the product (see Figure 1).

Step 1: Identify Conditions

The first step of AMD does not directly incorporate interface design research. Its purpose is to link the analysis and design phases together and to emphasize the importance of analysis as a foundation for design. . While it is outside the scope of this paper to discuss how to collect analysis and evaluation data, the author would like to stress the importance of this data. Therefore, in this step the instructional design team analyzes the conditions which surround the instructional context. These conditions are environmental, learner, or instructional needs which define or create boundaries for the instructional product. While collecting or compiling the conditions which result from

Figure 1. The integration of AMD into a cyclical design cycle



analysis or formative evaluation data, it is crucial that instructional designers identify answers for the following four analysis questions:

- **What is the content like?**
  (subject area, type of learning, scope of content, expected outcomes, instructional approach, etc.)
- **What are the learners like?**
  (age, ability level, experience level, motivation, culture, learning styles, student groupings, etc.)
- **What will be the final delivery environment?**
  (computer type, processor, speed, memory, disk space, operating system, network configuration, color, sound, and video capabilities, etc.)
- **What constraints are being put on the production process?**
  (time, cost, resources, etc.)

It should be noted that in a cyclical design process, evaluation results, not just analysis results, will also generate conditions which will create boundaries for the product. Sometimes these results will even de-emphasize the importance of some of the original pre-design analysis results. Therefore, it is important to include both pre-design analysis results and formative evaluation results since both of these types of data affect the conditions surrounding the instructional product.

Step 2: Select Design Features

The second step of AMD is to take the conditions which surround the instructional context and to select the design features which will best address those conditions. In the case of each condition, there are some features which should be avoided and others which should be included in the future design layout (Romiszowski, 1981, ch. 17; Gagné, Briggs, & Wagner, 1992, ch. 11). The research basis for these decisions should stem from media selection research studies and subsequent research summaries (Jonassen, 1996; Thompson, Simonson, & Hargrave, 1996).

The most important issue to remember during this step of the AMD process is that methods should not be chosen arbitrarily. On the contrary, instructional designers should use instructional and learning theories, media selection research, and personal experience to support design feature selection. All three of these areas are important sources of information. While some instructional designers may argue that professionals in the field disregard this step, the author would argue that is not the case. Professional designers have a high level of expertise because they have internalized much of the research and procedures involved in the design process. However, when they reflect on their product design, it becomes evident that they have selected features which were tied to effective learning of the content while taking into consideration the learner, environmental, and process conditions which surround the instructional context.

Example:

Let us imagine that there is an instructional designer who is working on an instructional product to teach Spanish conversational skills. In the first step of the AMD process, he discovered a number of conditions. For the sake of brevity, let us concentrate on three of those conditions, the content/skill of Spanish conversation, the low motivation level of the learners and the delivery computer configuration (networked 486 PCs with 8MB of RAM but lacking sound cards and CD-ROMs). During the second step of the AMD process, the designer will determine which design features will be most effective for these conditions (see Table 2).

Table 2. Selection of design features based on three conditions of content, motivation, and delivery computer specifications

Condition:	Features to Include:	Features to Avoid:
Spanish conversation	• Text • Graphics (to support text) • Digital audio • Digital video	
Low motivation level of the learners	• High interaction • Multimedia features (graphics, audio, video, etc.) • Learner control • Real-world examples (graphics, video, etc.) • Simulations	• Drill Structures • Fixed linear navigation structure
Networked 486 PCs with 4MB of RAM but lacking sound cards and CD-ROMs		• Speed intensive programming • Digital audio • Digital video

Step 3: Resolve Conflicts

The third step of AMD resolves the conflicts which may exist between the features to be avoided and the features to be included for all the conditions surrounding the instruction. Conflicts occur when a feature is desirable (to be included) with regard to one or more conditions and undesirable (to be avoided) with regard to another condition. There are four ways to resolve these conflicts:

- **Avoid the feature.**

  A conflicting feature which is not expected to significantly impact the effectiveness of the instruction can simply be avoided.
- **Include or avoid the feature according to the condition with the highest priority.**

  When feature selection varies with respect to different conditions, however one condition has a high-impact upon the product or the production cycle (such as instructional objectives or cost issues), the feature can be avoided or included with regard to the highest priority condition. The focus here is on maximizing the effectiveness of the instructional product within the constraints which surround its development.
- **Include the feature, but address its effectiveness during formative evaluation.**

  If it is uncertain whether a feature will improve instruction due to the conditions which surround it, the feature can be included in the design and while being flagged for formative evaluation. In this case, the risk of including the feature can be minimized by testing its effectiveness during the formative evaluation phase.
- **Renegotiate with the client.**

  Although it is not common, there are times when a conflict should be resolved through renegotiation with the client. This is the case when including or avoiding a given feature would compromise the effectiveness of the instructional product.

Example:

Features which are in possible conflict need special consideration. They are too important to simply be avoided since they meet certain conditions of the instructional environment. Sometimes the solution of these conflicts involves more than one of the four resolution strategies listed below. For example, the instructional designers who are designing the Spanish conversation product might decide to forego the aspects of multimedia since the delivery computers do not have the hardware requirements for such features. The addition of digital video would probably not have a major impact on the learner's auditory practice so it could be avoided without compromising the instructional effectiveness of the product. By avoiding digital video, the program would take up less storage space. However, it is crucial to have digital audio in order to teach the oral and auditory skills needed to converse in Spanish. In this case, there needs to be a renegotiation with the client since delivery conditions are in direct conflict with instructional effectiveness and there is no other way to resolve this conflict. In the end, the client agrees to invest in sound cards for the machines but not CD-ROMs. With the sound cards and the available hard disk space on the machines it is now possible to have digital audio. In this case, conflicts were avoided by using a combination of avoidance and renegotiation.

Step 4: Create the Design Layout

The fourth step of AMD involves the creation of the actual design layout. This layout takes the design features which are deemed effective for the conditions that surround the instructional product and gives them a form for the screen. Layout creation relies upon interface research and visual design research. The results of both of these types of research can be summed up with seven ABC's R' US design principles: alignment, balance, contrast, chunking, repetition (theme), utility, and simplicity.

- **Alignment**

  Alignment refers not only to the alignment of text, but also to the alignment of all visual objects. Objects have six points of alignment: right, center, left, top, middle, and bottom. The eye can perceive the strongest alignment when objects are aligned on the outer points on the right, left, top, and bottom.

- **Balance**

  The center of a page or a screen is its fulcrum of balance. Balance is achieved when the weight of the objects on the left side are relatively equal to those on the right side and when the objects on the top half are relatively equal to those on the bottom half. On a light background, objects which are darker have more visual weight than those which are lighter. On a dark background the opposite is true.

- **Contrast**

  Contrast is the level of difference in appearance between objects. Contrast can be achieved by placing a dark object by a light object or by putting a thin-featured object by a thick-featured object. If an object has a high level of contrast from its surrounding objects, it draws attention to itself. The key to effective contrast is to use it sparingly. If one object stands out on a page or on a screen, it will draw the learner's attention. If a number of objects contrast on a page or on a screen, they can distract or even confuse the learner.

- **Chunking**

  Visual chunking refers to the placement of objects. Objects which carry out similar functions, such as navigation buttons, should be chunked or placed in the same visual zone of a page or a screen. Likewise, text headings should be chunked with the text which supports them.

- **Repetition**

  Repetition has many related layers. It refers to the consistent use of objects, effects, fonts, sizes, styles, and colors both on an individual page or screen and also throughout the product as a whole. Repetition also refers to the metaphor or theme used throughout the product. In this sense, all objects should repeat and support the same visual message. .

- **Utility**

  Utility refers to the usability of the visual interface. It should be clear to the learner which objects are interactive and where the learner is located within the instructional product.

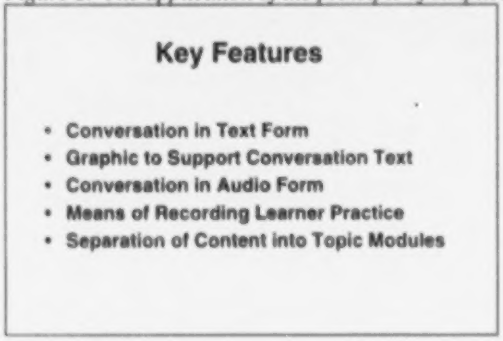
- **Simplicity**

  Simplicity addresses the appropriateness and the necessity of the visual objects on a page or on a screen. The purpose of visual objects is their instructional value not their impact value. Objects which do not support instruction can detract from learning. The key is to keep the visual design simple and only include those visual objects which are necessary to convey the instructional message.

Example:

The ABC's R' US principles are the keys to building a usable and aesthetically sound design. Let us see how the instructional designers use these principles to build the layout design for the practice screens of the Spanish conversation product.

Figure 2. The application of the principle of simplicity to a Spanish conversation project

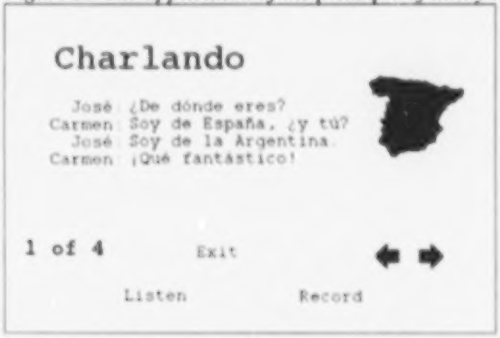


Key Features

- **Conversation in Text Form**
- **Graphic to Support Conversation Text**
- **Conversation in Audio Form**
- **Means of Recording Learner Practice**
- **Separation of Content into Topic Modules**

When building layouts for the various types of screens in a given interface, the principles are used in reverse. Therefore the designers use **simplicity** from the beginning of the design process, since the key to effective design is focusing on instruction and ease of interaction (see Figure 2). They select the key media features for the interface from steps two and three which are most integral to their goal of effective instruction. In the case of the Spanish conversation project, the key features are conversation text, a graphic to support the conversation text, a digital audio recording of the conversation text, a means of recording learner practice conversations, and separation of the content into separate topic modules (for future sample screens, the topic is "charlando (small-talk)").

Figure 3. The application of the principle of utility to a Spanish conversation project

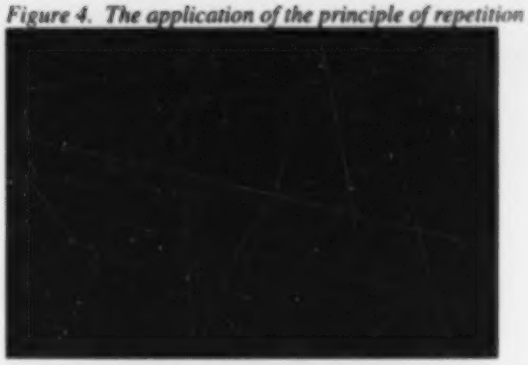


Charlando

José: ¿De dónde eres?
Carmen: Soy de España, ¿y tú?
José: Soy de la Argentina.
Carmen: ¡Qué fantástico!

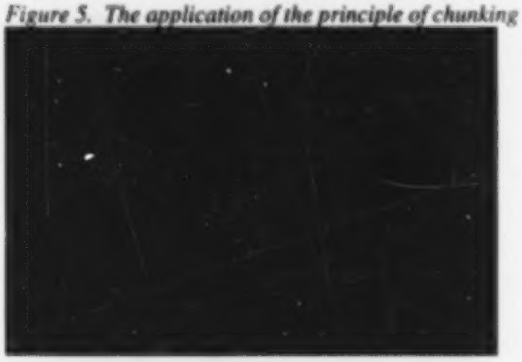
Next the designers focus on **utility**. They decide that each screen needs to have the following elements: a title, the text of the conversation, a simple graphic image to focus the learner on the topic of the conversation, a means of accessing the digital audio clip of the conversation, a means of recording the learner's practice conversation, a means of moving from one card to another, and a means of leaving the practice area of the program (see Figure 3). The designers decide to use a short tutorial on how to use the program at the beginning so that the learner knows how to interact with these elements and their is no need to repeat instructions for using the interface on each of the module screens.

Figure 4. The application of the principle of repetition (theme) to a Spanish conversation project



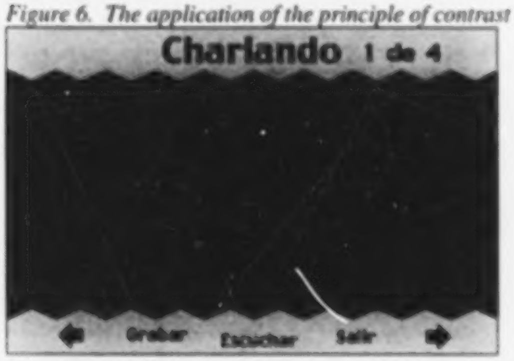
As they apply the principle of **repetition**, the designers decide to use a Spanish theme to echo the objective of teaching Spanish. The background image on the screen uses colors which are present in the flags and crafts of many Spanish-speaking countries. The pattern is based upon the pattern used in goods woven in several Central American countries. The screen reference and the words on the listen, tape, and exit buttons are in Spanish, as well, to repeat the Spanish theme. These thematic elements are repeated on all the module screens to create a Spanish look and feel to accompany the Spanish content (see Figure 4).

Figure 5. The application of the principle of chunking to a Spanish conversation project



Next the **chunking** of the interface elements separates like elements into the same visual zone. The zigzag red patterns also serve to break the screen into three different visual zones so that the various types of elements can be chunked separately. The top zone is used for the title and the page number. The middle zone holds the content of the screen (the text and accompanying graphic). The bottom zone is contains the navigation and interaction buttons (see Figure 5).

Figure 6. The application of the principle of contrast to a Spanish conversation project



After the elements are chunked into the different visual zones, the text and graphics in the top and bottom zones is no longer legible (see Figure 5). Therefore, the designers increases the **contrast** by using black text and light background colors to maximize the contrast and the legibility of the text in the heading, and the bottom buttons.

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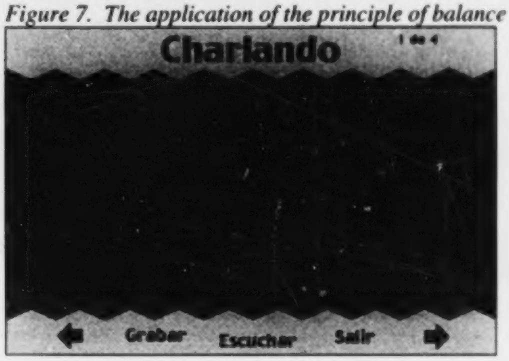
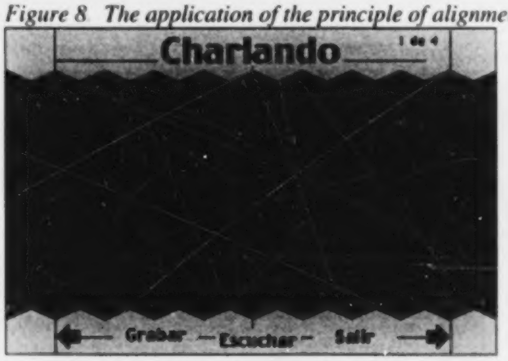
The light color also goes with the repeated Spanish theme which was earlier established. In addition, a heavier font is used for all text, including the conversation dialogue text, to increase legibility (see Figure 6).

Figure 7. The application of the principle of balance to a Spanish conversation project



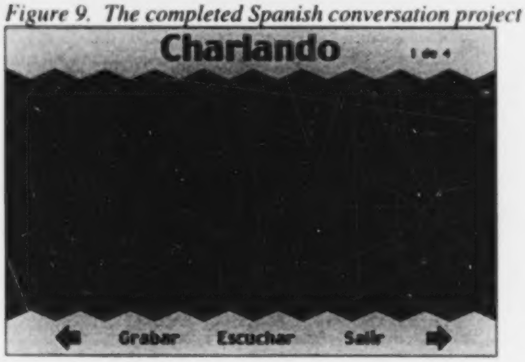
The interface appears **balanced** for the most part; however, the designers notice that the top zone needs some adjustment. They decrease the size of the module screen number so that it increases the left/right balance of the layout (see Figure 7).

Figure 8. The application of the principle of alignment to a Spanish conversation project



Finally, the designers **align** the outer edges of the text and the graphic with the outer edges of the arrow navigation buttons. All of the buttons are middle aligned, as are the text and graphic of the middle zone. The information top zone is bottom aligned to align it parallel to the red design (see Figure 8).

Figure 9. The completed Spanish conversation project



After working through the seven principles of the ABC's R' US, the finished design (see Figure 9) is now ready to enter the development stage where it will be the basis of the grid layout for the module screens.

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Conclusions

The changes in computer technology has moved the realm of interface design research from print-based guidelines to generative interface design research on media selection, interface design, and visual design. These three research types are integrated into the AMD process. The true strength of the AMD process lies not so much in its four-step process, but in its integration of these four design steps with current types of interface design research. The process tools of conflict resolution and the ABC's R' US design principles provide designers with simple ways to tackle interface design decisions. Although one example of the AMD process is included in this paper, future research could verify if using the AMD process and the principles of ABC's R' US increases the effectiveness or efficiency of the visual design process.

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The Affective Domain: A Model of Learner-Instruction Interactions

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Abstract

As instruction is now being designed with more regard to affective outcomes, the importance of a model to help the process has increased. Krathwohl, Bloom, and Masia (1956 & 1964) and Gephart and Ingle (1976) laid the groundwork for working in the affective domain. Keller (1983) proposed a model for the interaction of learners and instruction focusing heavily on the affective domain. Martin and Briggs (1986) later published a landmark book to help those in the field of Instructional Technology with the process of integrating the affective and cognitive domains. Using these sources as a starting point a more comprehensive model for instruction in the affective domain was synthesized. This paper therefore presents a model for those interested in the design and/or research of instruction in the affective domain. This model is an integration of current theories and models in the affective domain. It is a broad and comprehensive model which represents the hierarchical structures and interactions of affective and related cognitive factors, including attitudes, beliefs, values, anxiety, motivation, attributions, confidence, and interests.

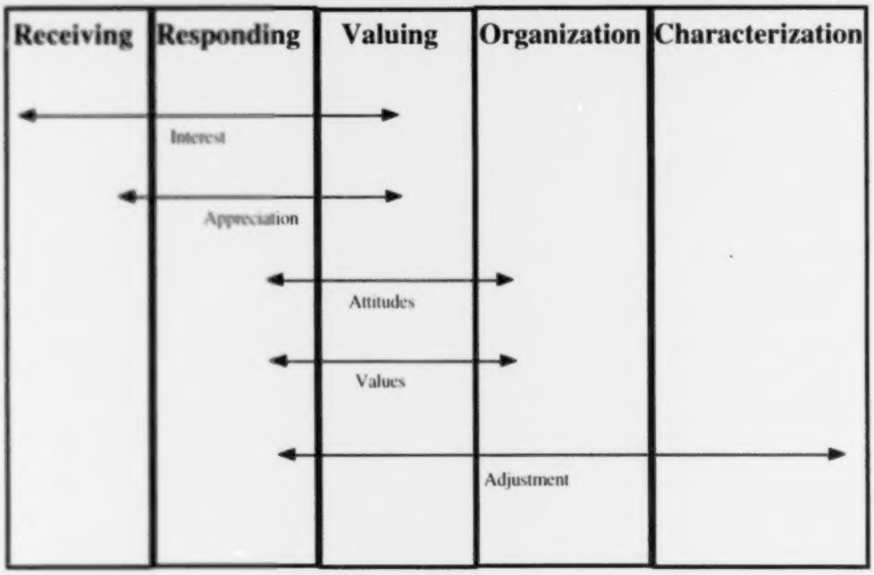
Theoretical Framework

Krathwohl, Bloom, and Masia (1956) developed one of the first taxonomies of educational objectives for the affective domain (see Figure 1). Krathwohl, Bloom, and Masia (1964) then added such affective constructs as attitudes, appreciation, and valuing within the hierarchy for the affective domain (see Figure 2). This enhanced taxonomy, however, had many gaps and did not contain many other important affective domain constructs.

Figure 1. Krathwohl et al.'s Taxonomy of the Affective Domain
(Adapted from: Krathwohl, D., Bloom, B., & Masia, B. (1956). Taxonomy of educational objectives. Handbook II: Affective domain. New York: David McKay.)

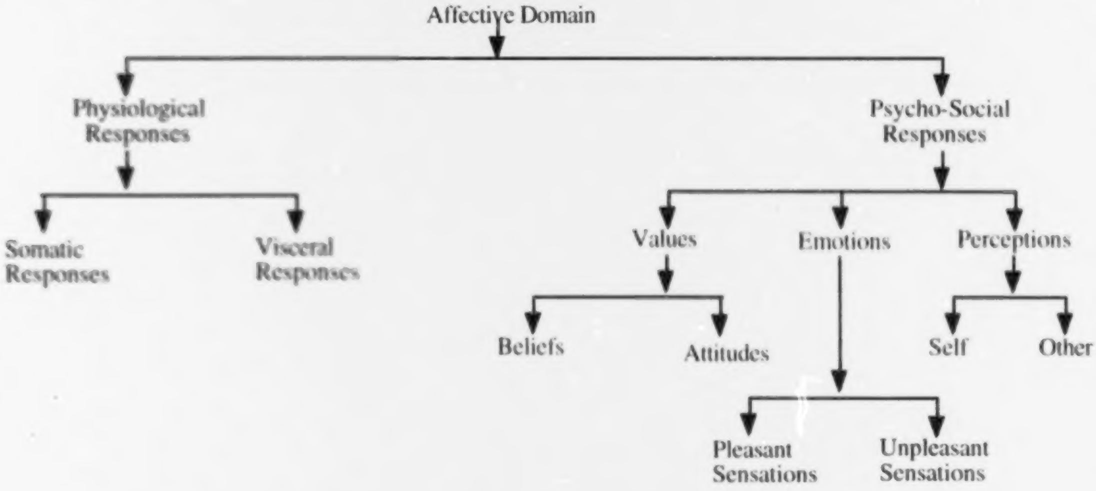
Level	Definition	Meaning
1.0 Receiving	Being aware of or attending to something in the environment.	I'll read an article about proper professional behavior, but I won't promise that I'll like it.
2.0 Responding	Sufficiently involved to the subject that one seeks it out.	I agree to attend several optional faculty meetings.
3.0 Valuing	Showing some definite involvement or consistent commitment.	I attend and participate in all faculty meetings.
4.0 Organization	Integrating a new value into one's general set of values, giving it dominance among one's priorities.	I volunteer to take a leadership role in the the faculty government.
5.0 Characterization	Acting consistently with the new value.	I help to restructure the faculty governance to improve its effectiveness.

Figure 2. Range of constructs in Krathwohl et. al.'s Taxonomy continuum.
(Adapted from: Krathwohl, D., Bloom, B., & Masia, B. (1964). Taxonomy of educational objectives. Handbook II: Affective domain. New York: Longman.)


Receiving
Responding
Valuing
Organization
Characterization
Interest
Appreciation
Attitudes
Values
Adjustment

Gephart and Ingle (1976) proposed a broader descriptive taxonomy of the affective domain (see Figure 3). While this model encompassed more of the affective domain, it still omitted several concepts usually placed within or linked to constructs in the affective domain (such as motivation, confidence, and attributions) and is limited in use for researchers and designers of instruction.

Figure 3. Taxonomy of the Affective Domain by Gephart and Ingle
{Adapted from Gephart, W. J. & Ingle, R. B. (1976). Evaluation and the affective domain. *Proceedings of the National Symposium for Professors of Educational Research.* Phoenix: ERIC}


Affective Domain
Physiological Responses
Psycho-Social Responses
Somatic Responses
Visceral Responses
Values
Emotions
Perceptions
Beliefs
Attitudes
Self
Other
Pleasant Sensations
Unpleasant Sensations

Keller (1983) presented a macro-model for the relationship of motivation, performance and instructional influence. Keller (1983) also developed a model for the design of motivating instruction. This model was later named ARCS -- an acronym for its four categories of attention, relevance, confidence, and satisfaction. Keller integrated the works of Bandura (1977) in self-efficacy, Weiner (1979) in attribution theory, McClelland (1976) in motives, and a number of other theorists into this model.

Building on the body of literature regarding the Affective Domain, Martin and Briggs (1986) published an award-winning book on integrating the affective and cognitive domains. The authors presented an instructional design model using audit trails for integrating the two domains. Later, Bohlin, Milheim, and Viechnicki (1993) integrating factor analyses of data from the motivational needs of learners with the macro and ARCS models presented by Keller, proposed a prescriptive instructional design model for motivating instruction-learner interaction. While this model had some promise for designers, it did not entirely provide for the needed more comprehensive coverage in the affective domain.

In addition, many other researchers outside of educational settings have provided some insights into how affective constructs might influence learners. Spielberger (1966) and Tobias (1979), for example, have performed significant work in the area of anxiety.

These previous models and theory structures are fairly comprehensive, however they individually lack the scope of the enough of the affective domain to help designers of instruction and research. There is a need, therefore, to synthesize and integrate a new more comprehensive instruction-learner interaction model for the affective domain. The importance of such a comprehensive model is that it would provides designers and researchers with a means for considering a greater number of affective variables when planning the research and design of instruction. Such a model also, hopefully, would provide a starting point for discussions regarding the relationships of various affective and linked cognitive constructs, as well as providing a framework by which instruction and research in the affective domain might be planned. This paper is an attempt to begin the creation of such a model.

Constructs

There are a number of variables important to those who work in the affective domain. Following are several definitions of some of the constructs that are in the Model of Learner-Instruction Interactions in the Affective Domain.

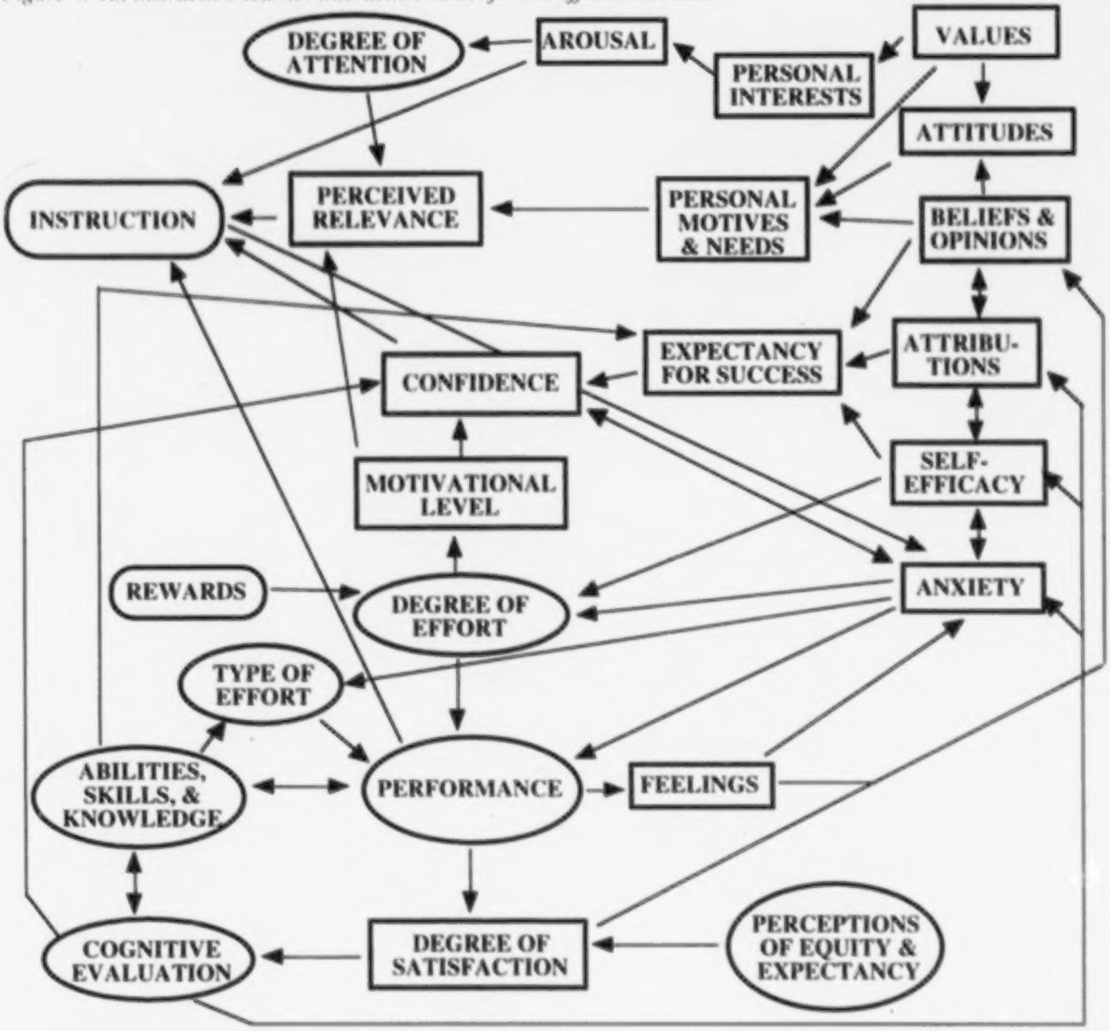
1. anxiety - an emotion described as the degree of fear or dread toward an object or situation
2. arousal - the level of stimulation being experienced by an individual which influences the level attention in that situation at that time
3. attitude - internal state or learned predisposition toward or against something or a set of things that have a some influence over an individuals choices
4. attributions - sets of inferences that one makes about the causes of success or failure related to ones behavior
5. beliefs and opinions - a set of convictions that one has accepted based upon ones experiences and interpretations of those experiences
6. confidence - the state of positive emotions and cognitions related to ones ability to successfully complete an expected task
7. expectancy of success - ones perceived likelihood of achieving a positive outcome in a given situation
8. interests - a set of preferences or tendencies toward some idea or object usually related to a stimulation of curiosity
9. motivational level - the degree of effort and the direction of that effort as to experiences or goals one approaches or avoids
10. motives - learned goal-directed tendencies which are directed by drives
11. perceived relevance - the degree to which a given situation is perceived by an individual as correlating with his or her needs and motives
12. satisfaction - a feeling that can be described as the extent to which the outcomes of a situation match ones expectations and perceptions of equity
13. self-efficacy - the degree of conviction that one has the ability to successfully cope and complete the behaviors necessary for the desired outcomes in specific situation
14. values - groups of attitudes organized around a central idea related to the perceived worth of that idea

The Model

The Model of Learner-Instruction Interactions in the Affective Domain (see Figure 4) shows the interactive relationship of instructionally important factors (such as attributions, confidence, attitudes, motivation, and values).

Constructs which interact with others are clearly shown with directional arrows. The model uses the following representations: (a) predominately affective variables are represented by rectangles; (b) predominately cognitive or behavioral variables are represented by ovals; and (c) external variables are represented by boxes with rounded corners. In addition, the model also shows those constructs which are dependent upon others, by using arrows to show the direction of influence.

Figure 4. An instruction-learner interaction model for the affective domain


DEGREE OF ATTENTION
AROUSAL
VALUES
PERSONAL INTERESTS
ATTITUDES
INSTRUCTION
PERCEIVED RELEVANCE
PERSONAL MOTIVES & NEEDS
BELIEFS & OPINIONS
EXPECTANCY FOR SUCCESS
ATTRIBU-TIONS
CONFIDENCE
SELF-EFFICACY
MOTIVATIONAL LEVEL
ANXIETY
REWARDS
DEGREE OF EFFORT
TYPE OF EFFORT
ABILITIES, SKILLS, & KNOWLEDGE
PERFORMANCE
FEELINGS
COGNITIVE EVALUATION
DEGREE OF SATISFACTION
PERCEPTIONS OF EQUITY & EXPECTANCY

Applications

There are several ways that this descriptive model can be used. First it can be used as a model for the planning of instructional interventions. Let's consider an instructional designer who is working with an audience that has some degree of debilitating math anxiety. Using the model (see Figure 4) it can be seen that anxiety can be affected by:

- cognitive evaluations related to ones abilities and knowledge in mathematics (for example "I don't understand how algebra works" or "I have never understood how to do formal proofs in geometry.")
- confidence related to the specific instructional strategies (for example the lack of visual aids for a very visually dependent learner, or individual work for a learner who needs to "discuss" ideas with peers before trying them).

- previous outcomes or results of instructional interactions (for example "I have never done well in algebra" or "I failed the last test even though I studied six hours".

The designer can therefore begin to examine ways to assess the needs of these learners to decide the best course of action for intervening in the debilitation of the anxiety.

Another use of the model might be for a researcher investigating affective variables. Research involving the construct of learner confidence, for example, can be identified to have effects from (see Figure 4) anxiety, attributions, self-efficacy, the specific instructional environment, abilities, skills, and knowledge. This model does not make any attempt to predict which effects are the strongest, for those are determined by the specific individual case. The model does attempt to be very inclusive so that many potential factors can be considered.

Third, Some constructs are directly determined by others (such as attitudes by beliefs or confidence by attributions). The model, therefore, suggests that if teachers (for example) want to change the attitudes of students, then they should work on the underlying beliefs of that attitude. For example, if I want to change a student's attitude toward using computers, then I should examine the beliefs of that student toward the use of computers in general and/or related specific beliefs (such as the belief about the uses of computers or beliefs about ones efficacy in using computers).

A fourth way that this model can be used is to examine how instruction might affect specific affective variables. For example, let us consider the construct of anxiety. Using the model, we can see that instruction does not directly link to anxiety, but it does connect through several indirect paths. One such path is through performance and the related feelings of the performance. Another is through performance and cognitive evaluation of ones improved abilities and knowledge (directly or through changes in self-efficacy or attributions). A third possibility is by providing instructional strategies that improve confidence levels about success in the instruction.

Limitations

This is not an instructional design model. It does not have an entry point to begin the process of designing instructional interventions. In order to design instruction using this model, one would have to also use an ID model of some type.

This model is not a prescriptive model. It does not directly provide strategies for instructional designers or researchers. As a descriptive interaction model, it merely describes suggested theoretical relationships among behaviors, affective constructs, and related cognitive factors. Users must have some knowledge of the nature of these variables to make appropriate inferences.

Implications

Much of the research into the affective domain has been rather fragmented, each concentrating on one or two affective constructs. The lack of a global vehicle to gain insight into the larger picture has represented a significant deficiency in making the affective domain accessible to practitioners and theorists. This paper is an attempt to begin to fill that gap, by providing a model that can help provide descriptive information on affective constructs. It is hoped that this model can increase the knowledge base of those practitioners and theorists interested in instruction and research in the affective domain.

We now have the opportunity to begin directing more of our focus and efforts into applications and research within this important arena. Researchers and designers can help to contribute more data to this model in a number of ways. They can help specifically if they:

- validate the theoretical connections in the model with research results;
- add prescriptions for specific variables based upon both research and best practice experience; and
- provide information about the best ID models for integrating inferences made from the use of this model.

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Visual Design for Interactive Learning Tools: Representation of Time-Based Information

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Abstract

The development of potentially powerful computer-based tools within rich learning environments is hampered by the constraints of delivery systems (specifically low-resolution, low -real estate displays). In designing a Web-based tool for manipulating time-based information the authors have encountered a lack of guidelines or empirical research to help resolve problems related to displaying timelines on 72 dpi, 640x480 pixel computer screens. In a study comparing linear vs. staggered arrangement of standard 32x32 pixel icons on an interactive timeline and found that subjects perform significantly faster when making temporal relationship comparisons with the linear arrangement of icons on a timeline.

Rich learning environments are often envisioned to contain, or even to revolve around, powerful computer-based tools (Allen & Otto, 1996; Barab, Hay, & Duffy, in press; Edwards, 1995; Land & Hannafin, 1996; Papert, 1991; Perkins, 1991). In the face of technical limitations (specifically, low resolution displays and limited screen space) that are prevalent in educational settings (President's Committee of Advisors on Science and Technology, 1997) the visual design problems entailed in actually implementing such tools are serious. Interface designers for computer-based learning tools need to be able to turn to guidelines and empirical research relevant to the representation of complex information in relatively low resolution environments for help in solving those problems.

Timeline displays in relatively low-resolution, low-real estate conditions

The authors of this study are currently involved in the design of a Web-based learning tool in which the display of temporal, or time-based, information is the primary vehicle for interaction. The tool offers multiple views of any single data set at varying degrees of detail:

a) a high level overview in which only clusters of data points are visible,
b) a mid-level view in which individual data points appear differentiated only by their duration indicators (bars drawn along a timeline),
c) a mini-view showing the user's current position in either the high level (a) or the mid-level (b) view, and
d) a detail view in which individual data points are represented by standard screen icons (32x32 pixels) which differ according to the predetermined topical category into which the data point falls. Each icon in this view is accompanied by a text title naming the data point and by a duration bar indicating the defined starting and stopping points in time for that item (Figure 1.).

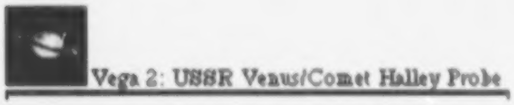


Figure 1. Single icon, text label and duration bar

The detail view (d) of this design presents particular problems in formal design; namely, the accurate representation of a reasonable number of data points in a format that best supports the quick and accurate determination of temporal relationships between events. Given a 72 dpi, 13" screen display (640x480 pixels), which is the stated or implied lowest common denominator in numerous commercial design publications (Kristof & Satran, 1995; Lopuck, 1996; Lynch, 1994; Niederst & Freedman, 1996; Waters, 1996), the limitation on the number of data points that can appear in a single display is quite severe. The practical design question becomes how to fit as many data points as possible on the screen and still provide a display of the information that affords efficient visual processing by the user?

Problems with guidelines

In surveying the available guidelines for screen design the authors encountered problems similar to those described by Lee and Boling (1995). Guidelines are frequently aimed at single dimensions of a display (size of text, use of color, placement of icons). Complex representations of information, like timelines, require the integration of multiple elements, all of them influencing all the others by virtue of the way they are combined . Single dimension guidelines are of little use in solving complex design problems.

Guidelines specifically regarding the design of data displays like charts, graphs and diagrams (including timelines) do not offer guidance for low resolution situations (Kosslyn, 1994; Fleming & Levie, 1996), or simply state that high-resolution is required for the effective design of such displays (Tufte, 1997). While Tufte may be correct in the pure case of designing optimal displays, the fact remains that developers of learning tools must do the best possible job within existing constraints.

Empirical research and timeline displays

To date the authors have found no empirical research specifically studying the effective design of timelines, for print or for screen. Numerous studies do exist, however, in which print displays have been used to investigate mental imagery related to temporal information, and cognitive processes in temporal problem-solving. This literature suggests that alternative representations should be available for learners depending on the nature of the tasks for which they will use temporal information (Friedman, 1989, 1990), that learners will not intuitively understand displays of temporal information (Uka, 1962), and that learners of different ages will have varying degrees of difficulty using such displays effectively no matter how well they are designed (Friedman, 1992; Levin, 1992).

Representing time-based information

The power of spatial representations of time lies in the simultaneous comparison of items in order to perceive relationships that are not readily discernible through experience alone. Every spatial representation of time emphasizes some aspect of the information at the expense of another (Friedman, 1990). Timelines, an instance of spatial representations of time, emphasize *duration relationships*, of which thirteen distinct types (Figure 2).may exist between any two given time durations (Allen & Kautz, 1985);

- equals (1),
- before/after (2,3),
- meets/met by (4,5),
- overlaps/overlapped by (6,7),
- starts/started by (8,9),
- during/contains (10,11), and
- finishes/finished by (12,13).

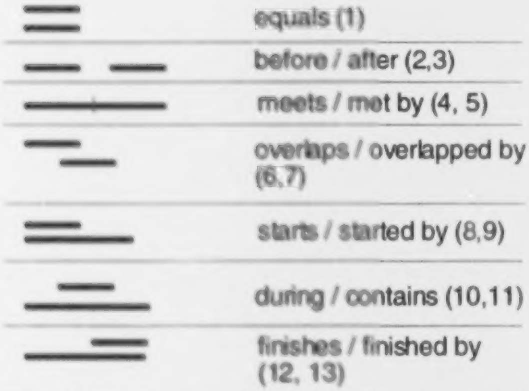

equals (1)
before / after (2,3)
meets / met by (4, 5)
overlaps / overlapped by (6,7)
starts / started by (8,9)
during / contains (10,11)
finishes / finished by (12, 13)

Figure 2. Visual representation of the thirteen temporal relationship types.

Although timelines are frequently used to represent temporal information, they are by no means universal - nor is the use of the abstract measures of time which allow such representations (Friedman, 1990). Our society is permeated with abstract measures and representations of time (and other forms of information), but we do not necessarily make effective use of any but the most basic and common displays (Tufte, 1983). In other words, there are no "universal" expectations or conventions that the designers of an interactive timeline display may rely on to be confident that its users will interpret its contents correctly, but there are some commonly used representations to which people may be more or less accustomed.

Paper-based timelines are often printed on oversized paper (on the horizontal dimension, if not the vertical), or reproduced at a very high resolution in order to capture all the text and images required to convey multiple events simultaneously. When the size or the resolution of a timeline is reduced drastically, our hypothesis is that the simultaneous perception of events may be compromised.

Pragmatic problems with screen size, resolution and timeline displays using 32x32 pixel icons

At 72 dpi, a 640x480 screen display includes a total of 307,200 pixels. At 1024 pixels per standard 32x32 pixel icon, 300 icons could fit on the screen in a tiled arrangement: providing they did not include text titles. In fact, after subtracting interface elements (scroll bars, window titles, timeline labels, etc.) at approximately 40 pixels vertically and 45 pixels horizontally (a conservative estimate based on one horizontal and one vertical scroll bar, a labeled timeline, and a 30 pixel vertical space for category labels, buttons and other interface elements) the remaining 595x440 display can only hold approximately 255 icons, again tiled. Allowing for a 64-pixel title per icon (64x32 pixels per icon), this number drops to 127 tiled icons in that same space. Of course, since the placement of the icons is dependent on their specific relationship to the timeline, they are never likely to be perfectly tiled so as to take maximum advantage of the available pixels. The effective number of standard-size icons that may fit on our hypothetical timeline screen is therefore some number fewer (generally distinctly fewer) than 127. Given the several thousands of data points possible in a given query for the project under development, it was a matter of some concern to the authors that the arrangement of those icons be optimized for this relatively limited display.

Smaller icons and other alternative displays

It is perfectly possible to envision simple solutions to the pragmatic problems in formal design for timeline displays in which the 64x32 pixel icon-plus-label constraint is removed; for example, events might be represented by titles and duration bars only, or even by duration bars only, at a savings of as much as half the vertical space required for individual items. The authors pursued experimentation with icon displays, however, for reasons related to discriminability and user preference.

Discriminability

Searching for individual items in a complex display can be made more effective when the items themselves exhibit high discriminability, or differences that clearly distinguish them one from the other (Horton, 1994; Wolfe, 1996). Pictorial representations (icons) are more discriminable than text labels alone (Fleming & Levie, 1993), and certainly more discriminable than duration bars alone. While the use of icons on a timeline does not dictate high discriminability (if an author uses the same icon for every event, for example), the ability to display icons on the timeline provides the possibility for representations of events to be well-differentiated.

Preference for icons

The user-collaborator working with the authors currently has expressed a strong preference for icons accompanying text labels on the timeline, and expects that students using the tool will want to create new icons and attach them to specific types of events. In the experience of the authors, similar preferences are frequently expressed by users and user-designers of screen displays. A few early icon studies in which preference measures were employed have revealed the same preference (Edigo & Patterson, 1988; Guastello, Traut, & Korienek, 1989)., although these findings are by no means universal.

Linear vs. staggered arrangement of icons on the timeline display

Two common timeline strategies (whether or not icons are used to represent data points) represent events as perceptual "bars," stretching from their beginning point to their ending point in a consistent relationship to a series of constant units marked off at the top or the bottom of the display. The two strategies vary only in the spatial arrangement of the bars representing events (Figure 3.). The first arrangement places each event successively higher on the screen display, and places each event further to the right depending on when that event begins in time (linear arrangement). The second arrangement conserves screen space by placing events arbitrarily on the vertical dimension at any time that there is room available for them (staggered arrangement).

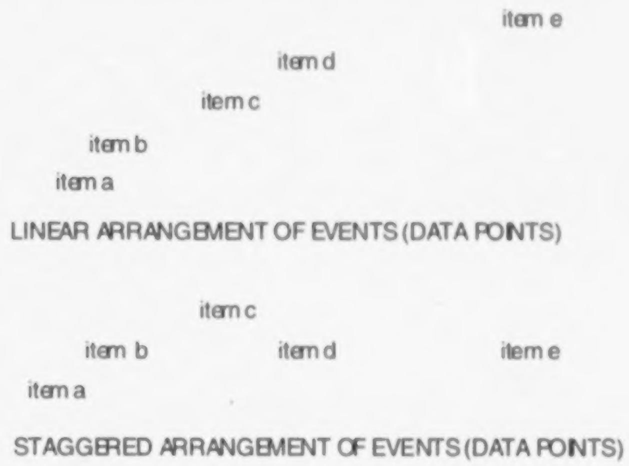

item e
item d
item c
item b
item a
LINEAR ARRANGEMENT OF EVENTS (DATA POINTS)
item c
item b
item d
item e
item a
STAGGERED ARRANGEMENT OF EVENTS (DATA POINTS)

Figure 3. Linear vs. staggered arrangement of generic event bars on a timeline.

Purpose of the Study

The authors conducted two studies to determine whether subjects using an interactive timeline work faster and make fewer errors in judging temporal relationships between pairs of events when the events on the timeline appear in a linear arrangement or in a staggered arrangement. The first study also examined subject's self-reported patterns of searching for items on the timeline displays, and their subjective impressions of the difficulty of using the timeline display.

A linear arrangement of icons on a timeline was expected to result in more scrolling of the screen display since every new data point appears above the previous one and the total display very quickly exceeds the screen space available without scrolling. A linear display was also expected to result in some loss of simultaneity since events that are close in time might not appear on the screen together, again owing to the steep rise created by placing each data point higher on the screen than the previous one (Figure 4). For these reasons subjects were expected to take more time judging temporal relationships using the linear arrangement.

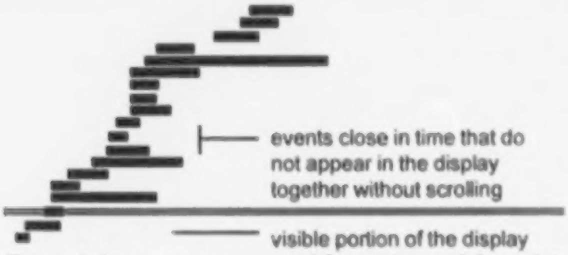

events close in time that do not appear in the display together without scrolling
visible portion of the display

Figure 4. Linear arrangement of data points with loss of simultaneity and high requirements for scrolling.

The staggered arrangement requires that subjects ignore differences on the vertical dimension in order to judge temporal relationships between events correctly, since events may appear either above or below others regardless of whether they begin earlier or later on the time scale. In addition, the staggered display was expected to be "noisier," with more icons appearing on the screen at one time, and therefore potentially distracting as subjects tried to judge relationships between events. The staggered display would also require scrolling for even moderately large data sets, although it was presumed not to require as much scrolling as the linear display. Consequently, the staggered arrangement was expected to result in more errors.

Method

Participants

Forty-two undergraduate students (19 men and 23 women, mean age = 19.4 years) at a large mid-western university volunteered to participate. All participants were recruited from non-major a class in the Telecommunications department. Volunteers were given partial credit towards a class assignment for participation.

Materials

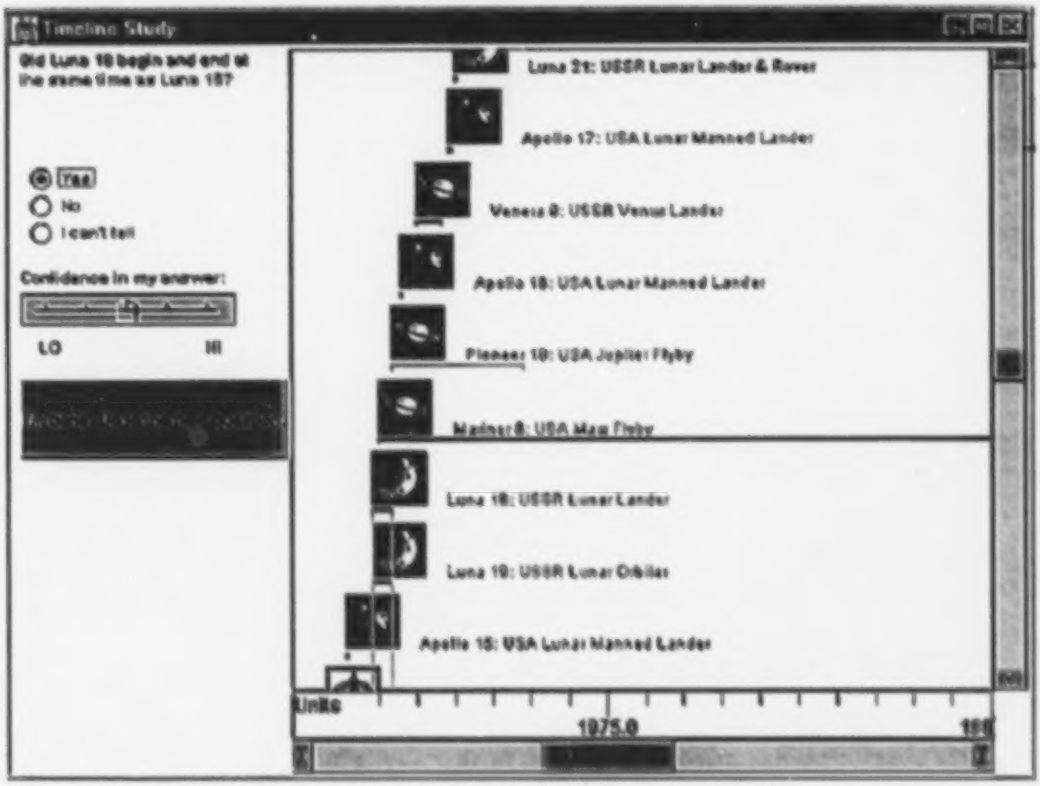
All test sessions were conducted in a computing lab run by the University. The lab was equipped with 40 computers, each running Pentium II processors, the Microsoft Windows NT operating system, and 64 megabytes of RAM. All displays were color SVGA, measured 15 inches diagonally, and were set to 800 x 600 resolution. The software used to run the data-collection instrument was HotJava version 1.1.

The data-collection instrument was a software program written in Java by the researchers. The instrument interface included several important features (Figures 5-6).

- A timeline/icon display which could be scrolled through both vertically and horizontally.
- Questions to the participant.
- Radio buttons providing a constant selection of answers to the questions ("Yes", "No", and "I can't tell").
- A button to retrieve the next question.

In addition, the instrument displayed several specific characteristics.

- The timeline/icon display consumed approximately 30% of the total display area
- Accompanying every icon was a thin black bar that stretched from the event's starting point to its ending point in accordance with the timeline below it.
- Clicking on the thin black bar associated with each icon caused light grey lines to descend from the starting and ending points down to the timeline.



Did Luna 16 begin and end at the same time as Luna 19?

● Yes
○ No
○ I can't tell

Confidence in my answer:

Timeline Study
LO
HI
Luna 21: USSR Lunar Lander & Rover
Apollo 17: USA Lunar Manned Lander
Venera 8: USSR Venus Lander
Apollo 16: USA Lunar Manned Lander
Pioneer 10: USA Jupiter Flyby
Mariner 9: USA Mars Flyby
Luna 16: USSR Lunar Lander
Luna 19: USSR Lunar Orbiter
Apollo 15: USA Lunar Manned Lander
Units
1975.0
198

Figure 5. Data collection instrument interface showing the linear arrangement of icons.

Procedure

Testing was conducted on various days over a two-week period between 9 a.m. and 7 p.m. Participants were allowed to select their own session times. As participants arrived at the lab they were met by one of the researchers and given instructions to review the study information sheet, sit down at an available computer of their choice, and log into the network using their university identification. All members of the research team used a script for the duration of the interaction with each participant.

From a deck of 50 shuffled cards (25 for each condition), each participant was given one card which had an 8-digit password printed on it that would inform the computer system which condition to present to the participant. Participants were then instructed to open the application called HotJava and enter the password on the card when prompted. Next the participants were provided a URL to enter into the application which called up the first practice screen for the instrument. At this time the screen was maximized to consume the entire display.

Participants were next given a short demonstration of the basic functionality of the instrument. The demonstration included navigating the timeline display using the scroll bars, activating the drop-down "legs", and moving on to the next question. If the participant did not have questions regarding the instrument, they were then presented with a second practice screen which they could use for as long as they wanted before beginning the test. Once the test was initiated, researchers did not interfere with the session.

Subjects answered 12 randomly ordered yes/no questions concerning the temporal relationship of two events on the timeline. Six temporal relationships (representing all the core relationships without their direct opposites, i.e., "contains" but not "contained by") were addressed by the questions, with two questions devoted to each. The timeline display remained exactly as the subject left it from question to question, so subjects frequently had to scroll the display in order to locate the events named in the question before they could answer since those events were not necessarily visible on the screen. The same twelve questions were answered by all subjects in both conditions.

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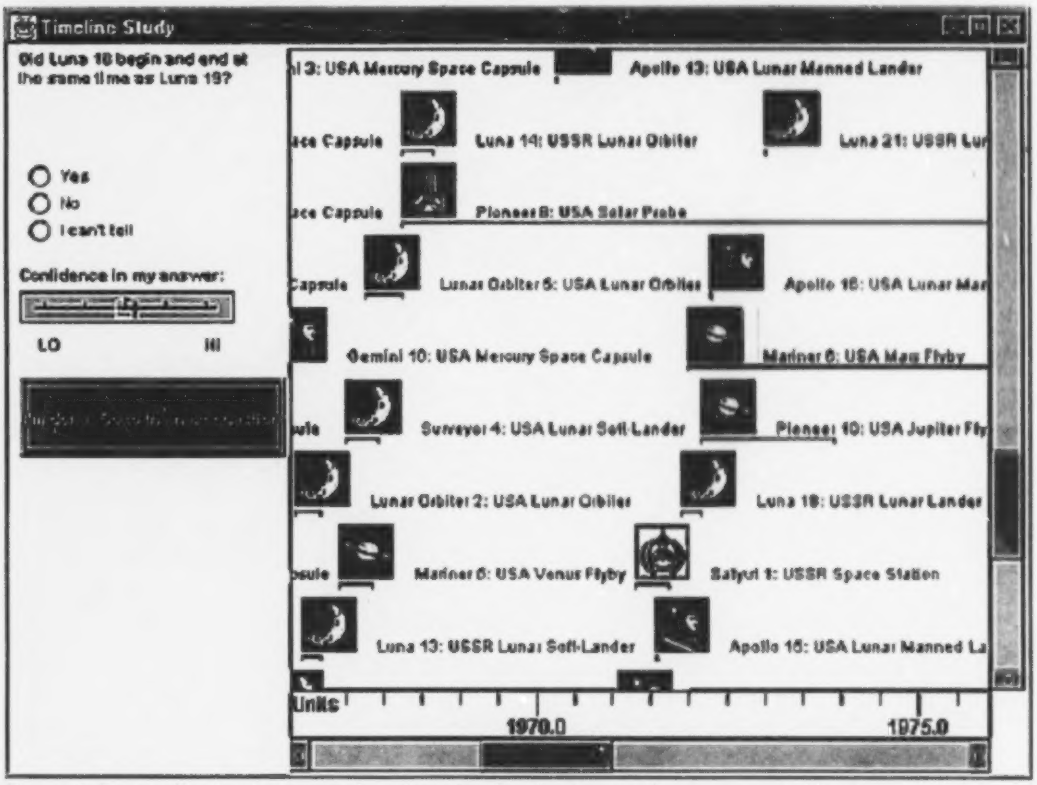
The instrument recorded three types of data.

- the length of time in seconds from the appearance of the second practice screen until the subject clicked to go on to the questions
- the subject's answer (yes, no, I can't tell) for each question
- the length of time in seconds from the appearance of a new question until the subject clicked to go on to the next question

All the data from the instrument were collected and stored automatically at the conclusion of each subject's session in a database located on a separate computer. The data were identified only by the time of the session and by the 8-digit password.



Did Luna 16 begin and end at the same time as Luna 19?

Timeline Study
○ Yes
○ No
○ I can't tell
Confidence in my answer:
LO
HI
l 3: USA Mercury Space Capsule
Apollo 13: USA Lunar Manned Lander
ace Capsule
Luna 14: USSR Lunar Orbiter
Luna 21: USSR Lu
ace Capsule
Pioneer 8: USA Solar Probe
Capsule
Lunar Orbiter 5: USA Lunar Orbiter
Apollo 16: USA Lunar Ma
Gemini 10: USA Mercury Space Capsule
Mariner 6: USA Mars Flyby
ule
Surveyor 4: USA Lunar Soft-Lander
Pioneer 10: USA Jupiter Fly
Lunar Orbiter 2: USA Lunar Orbiter
Luna 18: USSR Lunar Lander
psule
Mariner 5: USA Venus Flyby
Salyut 1: USSR Space Station
Luna 13: USSR Lunar Soft-Lander
Apollo 15: USA Lunar Manned La
Units
1970.0
1975.0

Figure 6. Data collection instrument interface showing the staggared arrangement of icons.

Results

Completion time

Completion time data were analyzed using a one-way analysis of variance, and revealed significant differences between the linear and staggered displays, F(1, 41) = 8.14, $p < .05$. Means indicated that subjects using the linear display took longer to complete the test (1182.86) than subjects using the staggered display (1151.04).

Answer accuracy

Answer accuracy data were divided into two parts for analysis, including correctness ("Yes"/"No") and uncertainty ("I can't tell "). One-way analyses of variance were conducted for both measures. A significant difference was found for correctness F(1, 41) = 4.52, $p < .05$, with means indicating that subjects using the linear display made more errors (1.42) than subjects using the staggered display (.57). No significant difference was found between conditions for the uncertainty measure.

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Answer accuracy with "overlaps/overlapped by" removed

Post hoc analyses revealed that removal of the "overlaps/overlapped by" temporal relationship from the data set resulted in no significant differences for answer accuracy across conditions. Further analysis revealed a significant difference for correctness, F (1, 41) = 6.21, $p < .05$, across conditions for the "overlaps/overlapped by" temporal relationship. Means indicated that subjects using the linear display made more errors on items that represented the "overlaps/overlapped by" relationship (.52) than subjects using the staggered display (.14).

Discussion

Completion Time

Results for completion time were inconsistent with the authors' original expectations. Subjects using the staggered display took approximately six minutes longer to complete the test than subjects using the linear display. The authors speculate that the amount of scrolling required to locate target events on the timeline using the linear arrangement was offset by the fact that subjects only needed to scan a single column of icons backward and forward in order to locate a target event. In contrast, subjects using the staggered arrangement had to scan entire screens of icons with no regular vertical or horizontal pattern. They also had to control the scrolling of the display more precisely to ensure that they had scanned every icon.

The pairs of target events required to answer questions could be seen on the timeline display at the same time for six questions in the linear arrangement and only three questions in the staggered arrangement, which means that the subjects using the staggered arrangement had to locate one event and then the other twice as often as subjects using the linear arrangement. Subjects using the staggered arrangement may have taken more time both in looking at the display and in scrolling around the display than did the subjects using the linear arrangement.

Once subjects using the staggered display located target events, they may have taken more time to identify the temporal relationship between events because the overall display they were scanning contained more visual noise (icons that were not the target events) than did the linear arrangement.

Answer Accuracy

Initial results for answer accuracy were also inconsistent with the authors' expectations. Subjects using the linear display made more errors than subjects using the staggered display. However, post hoc analyses revealed that removal of the "overlaps/overlapped by" temporal relationship from the data set resulted in no significant differences for answer accuracy across conditions. The authors had speculated that visual noise in the staggered arrangement would interfere with subjects' ability to make accurate identification of relationships and lead to more errors in that condition.

Answer accuracy with "overlaps/overlapped by" removed

Further analysis revealed that subjects using the linear arrangement made more errors identifying "overlaps/overlapped by" relationships than did subjects using the staggered display. The authors are unable to attribute this result to the questions themselves or to the nature of the temporal relationship, and unable to explain what element or elements of the displays might account for the result.

Limitations of the study

Temporal relationships between events are easier to see in diagram form than to describe in question form. The authors recognize that more rigorous pretesting of the stimulus questions is required to ensure that the questions are stated as clearly as possible.

The data set chosen for the study, manned and unmanned space exploration missions, was chosen from several candidates for which there was ready availability many defined data points. The authors speculated that the content of the data set might be perceived as scientific and therefore somewhat neutral, or even mildly appealing to more than one audience. The unanticipated result of this choice was that almost all the events named in the stimulus questions were numbered (Venera 3, Mars 5, and so on). Subjects reported incorporating this feature of the data set into their search strategies in both the linear and the staggered arrangement conditions by searching for an event of the same name, noting its number and then scrolling either forward or backward depending on whether the number of the target item was higher or lower than the one found . Although the study will have to be duplicated with a different data set to determine what, if any effect, this choice had on the results of the study, the authors anticipate that the effect may apply equally to both conditions since subjects in both conditions reported using the numbers to search

Although the logical anticipation of the authors was that staggered displays might afford easier comparison of events because more events could conceivably appear on the screen at one time, the displays created by the algorithm in the instrument did not conform to this expectation. Of the twelve items, six in the linear condition showed both target events on screen at the same time compared to only three in the staggered condition. The authors recognize that this outcome may have affected the time required for subjects in the staggered condition to search for target items. Experimentation will have to be done with multiple data sets to determine whether the displays for this instrument were typical.

Conclusion

Despite the limitations of the study, the difference in time taken between subjects in the linear and staggered timeline conditions strongly suggests that linear arrangements may be a more efficient representation for time-based information in low-real estate displays than are staggered arrangements with respect to searching for specific events.

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Measuring the Learning Cost of Presentation Interference

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Abstract

The purpose of this study was to determine the effects of presentation interference on students' ability to learn from, and their beliefs regarding, computer-generated presentations. Informed by single-element screen design studies and professional practice, this combined-element study compared a contextually based, intentionally interference free presentation against two presentations containing multiple, typical design flaws. One hundred and eighteen undergraduate students were randomly assigned to three groups and subjects individually viewed one of the three treatments. Following the presentation, subjects completed a posttest and a belief questionnaire.

Three hypotheses were tested: subjects receiving presentations with no intentional presentation interference would perform better on the posttest; subjects receiving presentations with less interference would perform better than those receiving presentations with more interference; and subjects in the interference-free presentation group would report more positive beliefs regarding computer generated presentations than would subjects receiving presentations with interference.

Results indicated significantly higher posttest scores for the interference free presentation group than for either of the two groups receiving presentations containing interference. Results also suggest that increasing intentional interference does not always lead to increased learning cost. In some contexts, elements that can be reasonably expected to hinder learning may have positive or neutral effects. Subjects in all three groups agreed that computer generated presentations are generally beneficial, however responses from the group with no interference and the group with four intentionally introduced types of interference were both significantly higher than responses from the group with two intentionally introduced types of interference. Although the well designed presentation and a presentation containing intentional interference both resulted in strong beliefs regarding the beneficial nature of computer generated presentations, treatments containing presentation interference significantly reduced learning.

Introduction

The advances in presentation media have been so exciting that many people have focused on the media and have forgotten to examine critically the purpose, the content, and the overall visual appearance of products. Particularly in cases where there is no instructor to clarify meanings and relationships, it is vital that the message(s) of a presentation be easily accessible. Poorly designed screens have the potential to turn learners' attention away from the message and onto the delivery system itself. Although many design guidelines have been produced, the limitations of most standards are that (a) assertions are not fully supported by research , (b) context is ignored, and (c) prescriptive guidelines are not conducive to formative and summative evaluation processes. Research is needed that combines design elements in realistic ways to determine factors or combinations of factors that hinder learning while acknowledging the context-driven nature of successful design decisions. Further, developers need a method of evaluation and feedback that can be used to improve existing presentations.

Purpose of the Study

A review of screen design research shows that most studies focus on the effects of a single element (as opposed to multiple element) change on subjects' ability to learn from presented material. Although studies indicate that single element changes can affect learning, most existing research does not address the difference between what was learned from a realistic presentation and what could have been learned from a rigorously critiqued and revised presentation.

The present study used a different approach. First, an "error free" visual arrangement for a specific content area was developed. This was accomplished by adapting screen design prescriptives from research and professional practice to a specific presentation topic. Individual screen elements (e.g., color, text, etc.) were handled according to established guidelines from professional practice and single element research, insofar as results from such prescriptives were appropriate to the context. Next, the presentation was critiqued by three professional presentation developers, revised, and approved as "error free," that is, no distracting flaws were detected. Finally, the study

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compared the error free version against two additional presentations to which presentation interference had been intentionally added.

Researchers (e.g., Seels, 1994) have called for more specific, operationally defined constructs that can be used in multiple element research. The term "presentation interference" is used in this study to refer to distracting flaws in presentations that may result from poorly combined, or inappropriate uses of, individual screen design elements. Identifying and labeling presentation interference is one step toward the development of both better screens and a contextual approach to multiple element screen design research. The purpose of this study was to determine the negative effects of presentation interference and to lay the groundwork for future research. In addition, the results of this study will contribute to research-based guidelines and a presentation evaluation method that can be used during and after presentation development to help designers identify and eliminate interference.

Justification

Existing research-based prescriptions tend not to go beyond studies of single elements (e.g., text size). Screen design researchers have avoided examining the effects of more than a single element for two primary reasons: (a) when individual elements are combined, effects cannot be clearly attributed to one factor or another; and (b) because effective screen design is not context neutral, screen design from an effective presentation cannot automatically be imposed on another topic. However, these typical generalization methods, albeit ostensibly tidy, are not very realistic. Actual presentations contain more one element and generally more than one type of presentation design flaw (referred to here as presentation interference). Further, the combination of elements may produce an effect greater than the sum of effects from elements examined individually (Mukherjee & Edmonds, 1994). Existing single-element studies have tried to attribute learning gains to a specific manipulation of an element being studied (e.g., 18 point bold text versus 14 point plain text), often with recommendations that the element be handled by other developers in exactly the same way as produced the better result in the particular study. Some studies are misleading because even the treatments with the best results were not designed according to professional layout standards. Further, most guidelines encourage novice designers to follow positive statements (e.g., "use complimentary fonts"). Such statements create problems because designers may think they have followed the directions, yet still produce poor designs. With typical prescriptive guidelines, designers have no external source of feedback or evaluation.

The present study has taken the reverse approach to the problem. Rather than comparing two "realistic practice" treatments and prescribing the one that produces the higher gain, the present study measured the results from an interference-free presentation design against results from versions representing "realistic practice." The difference between what was learned from flawed versions and what could have been learned from the error free version is referred to in this study as "learning cost." By identifying and measuring the lost opportunity for learning that results from screen design flaws, evaluation guidelines can be produced that help presentation developers identify and eliminate errors in presentations that may distract learners from the messages. Such guides (e.g., Bradshaw 1997b)would fit naturally into formative and summative evaluation processes.

Relevant Issues

Visual Literacy

Any research on screen design must be informed by the field of visual literacy. Conversely, findings from screen design should add to and support this relatively young field. After only 25 years of research and exploration, the field of visual literacy and its constructs and vocabulary are not yet fully explored. Dwyer (1972) developed a program of research to identify, classify, and measure "essential stimuli characteristics" of media. Braden and Hortin (1982, cited in Hortin, 1994) attempted to categorize and define the subsets of visual literacy. Baca (1990, cited in Braden, 1994) surveyed 52 visual literacy experts in an attempt to identify constructs of visual literacy. From this study, Baca provided one of the simplest and most recent definitions of visual literacy to refer to the use of visuals for six purposes: communication, thinking, learning, constructing meaning, creative expression, and aesthetic enjoyment (p. 3). The first four of these purposes are immediately relevant to screen design and to the educational purposes for which screen design is employed. Baca's definition reflects the pervasive nature of visuals, both in and beyond education.

Braden and Baca (1991) presented a conceptual map of the visual constructs identified in Baca's survey. In a graphic representation, the six elements of Baca's definition radiate from "purpose." Each of the six elements can then be further elaborated in separate diagrams. For example, "visual literacy" used to describe visuals for the purpose of learning, can be expanded in a separate diagram. The secondary diagram can illustrate the goals of learning including, among other goals, developing the ability to create visuals and the ability to acquire information from visuals (p. 158). Both of these particular goals have strong links to another of the six basic purposes of Baca's definition, aesthetic enjoyment.

Aesthetics serve a greater purpose than simple enjoyment. Aesthetic principles applied to screen design may make learning more accessible by structuring and organizing information. Visual literacy not only allows both students and teachers the ability to understand visual information, but also the ability to develop and present information that is more accessible to other viewers. Fredette (1993) stated, "Aesthetic ways of knowing must become part of the basic education of all students" (p. 66). Visual literacy is vital in a time when most teachers have access to, and encouragement to use, programs such as *PowerPoint* to aid in the presentation of information. Art and aesthetics may be as important to educating and learning as are reading, writing and arithmetic. Several researchers (e.g., Bertoline, Burton, & Wiley, 1992) have recommended that visual literacy be incorporated into curricula or specific courses, including mainstream communication courses. For at least two decades, educators such as Broudy (1977), who asked, "Is 'Rt [art] the 4th R?" have called for a more central role of visual literacy in education.

Although neither visual literacy broadly nor screen design specifically have an overt, widespread presence in education, screen design and presentation issues may well be covertly operating and affecting learners' abilities to understand and learn from material presented in classrooms. In all subject areas, educators are feeling pressure from administration and peers to include technology in their classrooms. Electronic presentations offer one of the most visible and accessible ways to meet this demand. Instructor-controlled, computer-based presentations are an intermediary step between the traditional lecture and more broad incorporation of technology, such as using computers as the main delivery method for instruction, tutoring, and practice. If the visual arrangement of information on computer screens affects learning, aesthetics must be acknowledged and incorporated into screen design.

Identifying Appropriate Vocabulary

Can poorly-designed presentation screens produce negative learning effects? If so, what are those effects on learners' comprehension and retention of message content? In asking the question, it becomes clear that one of the factors that may be hindering the movement into research on the overall effects of the combined elements of screen design is vocabulary. How does one refer to the negative phenomena resulting from poorly combined individual elements of screen design? The terms studyability, comprehensibility, noise, and interference are discussed below.

Studyability

The term *studyability* was introduced by Grabinger (1993) to describe "the ease with which a user can examine and learn from a screen of information" (p. 37). The term has not been widely adopted by other researchers and is somewhat limited in that a concentration of effort on the part of the learner is implied that is not always present.

Comprehensibility

The term *comprehensibility* has been used to describe the overall effectiveness of a screen to transmit information to viewers (Grabinger, 1989; Pettersson, 1994). The term measures the positive effects of the arrangement of screen elements. A high degree of comprehensibility would mean that the message of a particular screen is easy to access.

Noise

The term *noise* is sometimes used to describe visual phenomena that interfere with delivery of a message. In their review of the literature, Mukherjee and Edmonds noted that "one does not have to look far to find computer interfaces and screens that generate 'noise' and hinder instruction and the communication of messages" (1994, p. 112). Shannon and Weaver used this term in their model of communication to describe phenomena that alter messages so that what is received is different from what was sent. For lack of a widely accepted term, *noise* is useful but can become less so when applied to audiovisual or multimedia applications because discussion of metaphorical noise can be confused with literal audio noise.

Interference

The word *interference* is significant in several fields. In cognitive science, the term refers to prior knowledge that interferes with the acquisition of new knowledge. Cognitive science studies show that interference turns attention away from the message. The term is also used in communication. In broadcasting, for example, it is used to refer to the noise resulting from poor signal transmission that interferes with clear reception. Whereas *noise* implies a change in the message, *interference* suggests the possibility that the message may not even be received. Interference is not without precedent in visual communication. Bertoline, Burton, and Wiley (1992) state,

> Interference is the undesired outside influence that tends to prevent the completion of effective communication. It can occur at any level or stage in the process. The goal of any communication is to eliminate or minimize the influence of interference and thus maximize effective communication. (p. 252)

Pettersson (1993) uses the term in discussing the need to avoid unnecessary elements in visual design: "Too many details and too much complexity give rise to distracting 'interference' and reduce the interest for the content and the impact of the important part of the content of the visual" (p. 227).

Interference is a particularly useful term that is not limited exclusively to one medium. The term works equally well in describing print-based or computer-mediated instruction, two areas often seen as unable to apply identical solutions. *Interference* can be applied easily to projected presentations or multimedia applications to describe any element of the program, visual or audio, that hinders message reception. Where *comprehensibility* can be used to describe the overall positive effect of visual arrangement, *interference* describes the individual or combined elements that negatively affect visual or audiovisual designs.

Several types of flaws (i.e., inappropriate color choice, unreadable text, design flaws in charts and graphs, etc.), or combinations of flaws, contribute to poor overall design. These types of design errors, referred to here as *presentation interference*, have a potentially negative effect on learning from visually supported presentations, for two primary reasons. First, screens that are well designed provide for easier cognitive organization (e.g., Hannafin & Peck, 1988); the learning process itself is easier. Second, gaining and maintaining learner attention is a vital component of instruction (e.g., Fleming & Levie, 1978). When learners form negative attitudes toward presentations or attention is misdirected toward irrelevant components, learners may become less engaged in the learning.

Presentation interference includes any delivery- or presentation-related factor that distracts the learner from the message content (Bradshaw, 1996a). Inappropriate uses of specific elements can lead to presentation interference, some examples of which include

- meaningless or inconsistent sound effects or screen transitions
- inappropriate colors (e.g., color coding, fit to subject, fit with other colors)
- inappropriate typography choices (e.g., size, font, style)
- inappropriate graphic choices (e.g., size, style, format)
- inappropriate placement of elements
- inappropriate or inconsistent alignment of elements

The term "presentation interference" is also applicable to portability-related distractions. Elements such as color or graphical characters that are appropriate for one cultural audience, for example, may be extremely distracting for another (Bradshaw, 1996b). Necessarily, presentation interference is context driven. A more thorough guide to suggested categories of presentation interference, including examples and a rubric for use in screen design critiques has been developed and used by the author (Bradshaw, 1997b).

Poorly Designed Visuals

Some educational researchers view the lack of visual or instructional training as just two more problems in a long list of unprofessional uses of instructional tools that will have little effect on the legitimate work of those trained in educational technology (e.g., G. Morrison, personal communication, February 13, 1995). Others, particularly those with interests in visual literacy, are concerned that the "slick feel" of modern media lulls users (both teachers and developers) into accepting many presentations and software programs as instructionally "valid" and "good," regardless of their actual educational worth. When computer presentations are delivered via projection systems, such as LCD (liquid crystal display) projectors and panels, the problem is exacerbated. This investigator's experience has been that the use of this equipment may exaggerate the effectiveness the presentation in the mind of the presenter without necessarily improving learning.

Much remains to be explored regarding the learning costs of poorly designed visuals in instruction. If visual design *can* affect learning, instructional designers must consider both the delivery method and appearance of instruction in addition to the content and strategy. Haag and Snetsigner (1994) agree that, "as form and function go hand in hand so, too, must instructional design and aesthetic design. They are inextricably connected" (p. 94).

Hardin (1994) has suggested the problem of poorly designed visuals could be solved if teachers would simply practice developing materials. Regarding the production of charts and diagrams, Hardin said, "we should encourage non-designers to produce frequently on the theory that practice will increase skill" (p. 24). But practice does little good without credible, empirically based guidelines. Practicing visual design with neither attention to visual design principles nor expert feedback is just as likely to reinforce bad habits and poor techniques as it is to develop expertise. The argument is somewhat moot, since few teachers have the luxury of spending time practicing designs that they have no intention of actually using.

Screen Design

In their review of the literature on screen design, Mukherjee and Edmonds (1994, p. 115) noted that the general functions of screen design are to

- focus learners' attention
- develop and maintain learners' interest
- promote deep processing
- promote engagement between learners and lesson content
- help learners find and organize information

Instructional design journal articles, chapters, and books focus on the above screen design functions and occasionally focus on the role of specific screen design elements in achieving these goals. Hannafin and Peck (1988), for example, link screen design to purpose and screen type: transitional, instructional, and question. In many instructional design books (e.g., Criswell, 1989), specific purpose screens (e.g., title, menu, instruction, practice, feedback) are emphasized more than the particular visual design elements within these screens. Emphasis is given in general terms, such as to the need for standard screen components (e.g., navigation controls), functional areas, (i.e., where titles should appear and what portion of the screen should be reserved for graphics), and types of visuals (e.g., charts, graphs, etc.). Guides of the type described are not generally accessed by most "nonprofessional" screen developers and are intended for "front-end" use. However, presentation media developers, many of whom are teachers who develop their own materials by necessity, also need a system that can be used in a follow-up evaluation process, one that is specific enough to catch design flaws while being flexible enough to accommodate specific contexts.

Lack of Research-based Guidelines

Although much screen design literature provides strategies for screen design, Mukherjee and Edmonds (1994) found that most design strategies are not supported by research evidence or experience (p. 113). Some design texts are supported in small part by research, yet even in these cases there are often unattributed statements such as "black and yellow are the most readable combination." While statements such as these may well be backed by research, citations are not provided. There is a conspicuous lack of research to support the intuitive sense that instruction that *looks good* should make learning easier. Even within the research community, not all of the overall guidelines (that address more than a single element) are entirely based on research and, where guidelines are research based, specific guidelines are not always linked to specific studies (e.g., Fleming & Levie, 1978). Examples of non-research-based or partially research-based prescriptive guidelines include those by Keyes (1993), Lenze (1992), Pettersson (1993), and Milheim and Lavix (1992). Kosslyn's (1989) thorough article "Understanding Charts and Graphs," which points out design flaws and provides cognitive rationales for design choices, is an excellent guide for the development of charts and graphs but does not provide research evidence to support prescribed design choices. Misanchuk (cited in Grabinger, 1993) states that while aesthetic guidelines exist to help designers create attractive displays "aside from Hartley's (1978) work, there are few, if any, empirically based guidelines to help instructional designers combine text elements in ways that facilitate learning" (p. 35).

Practical Guidelines

Achieving screen design goals using specific visual design elements has been the focus of several textbooks, such as Rabb's (1990) Presentation Design Book, although most visual design texts have been written primarily for print media (Hartley, 1978). Typical examples of guides to visual design include desktop publishing and basic design books, such as Text, Typography and Layout for Desktop Publishing (Silver & Silver, 1991). Desktop publishing software producers often develop their own layout and design guides. Aldus published a basic design book (Kerlow, 1991) that included tutorials for *PageMaker 4.0*. A wide variety of magazine and journal articles have also been written to aid the growing population of novice software producers, such as Olson and Wilson's (1985) simple checklist for designing computer screen displays and, more recently, guides such as those by McFarland (1995), Wilhelm (1996), and Strasser (1996), and guidelines available via the internet (e.g., Radel, 1995)

As electronic media become more accessible, more prescriptive articles appear in a wider variety of journals and magazines. The majority of these works rely on common practice and "common sense," as opposed to findings from research. One of the problems with approaching the concept of "good screen design" is that there is no possibility of an ultimate solution. "Good design" is not context neutral – specific arrangements that work well for one content area and audience do not automatically work well for all other content areas and audiences. Still, this has not stopped the production of prescriptive guidelines calling for specific text sizes and color combinations that should be used in any case.

General Screen Design Prescriptives

Categorizing specific screen design elements and then manipulating elements within each category has been referred to by Mayer (1984) as a "behavioral" approach. This has been one of the most common ways to approach an initial understanding of screen design and is the method used in most existing screen design research. Although a useful place to start, the method is limited because general prescriptives are not equally relevant to all settings. Much of the existing prescriptives focus on the following elements: text, graphics, color, line, animation, and consistency. The prescriptives that follow, although not exhaustive, are typical of those found in the literature. They are based on professional practice, general heuristic, and research.

Text

Several researchers (e.g., Hathaway 1984; Mourant, Lakshmanan , & Chantadisai, 1981) report that large amounts of text cause eye fatigue. Researchers (Hartley, 1987; Hathaway, 1984; Morrison, Ross, & Dell, 1988, cited in Knupfer, 1994) also report that large amounts of text are more likely to be forgotten. Soulier (1988) suggests that when a great deal of text is called for, it is better to print the text out.

Text displayed in all capital letters is difficult to read (Pettersson, 1993), therefore, in most cases, text should contain a mixture of upper and lower case characters. Ross and Morrison (1988) also suggest using low-density text, reducing ideas to one idea, and using outline format. In many cases, minimal drop shadows can make text more legible.

Regarding the use of serif or san serif fonts, suggestions from the literature are mixed. It is generally accepted that what readers are used to reading or personally prefer will be easier for them to read (Dreyfus, 1985). Some researchers suggest that small serifs should be used for printed material and sans serifs be used for computer and projected material (because thin serifs do not generally project well).

Gibson and Mayta (1992, cited in Knupfer, 1994) suggest that for computer-displayed text, text size should not be smaller than 26 points. This prescriptive creates a problem, however, because not all 26-point fonts are visually the same size. For computer-displayed text, Gibson and Mayta also suggest using bold text throughout, or at least for headings and key words. Again, this must depend on the specific typeface used because some fonts are already "heavy" and bolding may actually make them less readable.

Graphics

Soulier (1988) describes graphics as visual metaphors. Graphics aid in motivation and maintaining attention by adding variety, thereby making the screen more interesting (Kemp & Dayton, 1985). Aspillaga's (1991) research suggests that placing graphics close to corresponding text results in significantly higher achievement than placing them elsewhere on the same screen. In cases where information must be split to two screens, Soulier (1988) suggests placing the graphics after the text. This contradicts Pettersson's (1993) suggestion that developers achieve priming by placing graphics before related text.

Researchers (e.g., Pettersson, 1993; Fleming & Levie, 1978; and Soulier, 1988) report that simple line drawings are generally more effective than complex drawings or photographs because they contain only relevant information; less information requires less time to interpret.

Color

In general, the most highly preferred surface colors for adults are blue, red, and green (Pettersson, 1993). Generally ranked lowest are violet, orange, and yellow (Fleming & Levie, 1978). The most visible colors are white, yellow, and green (Pettersson, 1993). The least visible, assuming equal intensity, are red and blue (Fleming & Levie, 1978). Researchers (e.g., Pettersson, 1993; Fleming & Levie, 1978) agree that the most readable color combination is black and yellow. A good general guideline is to start with a fairly light or fairly dark background color that is appropriate to the content, and then choose an opposite (fairly dark or fairly light) color for text (Bradshaw, 1997a). This general strategy allows for color combinations that are appropriate to the specific topic and allows for more creativity while still ensuring readability. Rather than focusing on specific colors as always best, developers should work to ensure contrast between background and text.

Dwyer (e.g., 1972, 1978) has conducted many studies on color and reports that color coding and cueing increase learning. Hannafin and Peck (1988) suggest bright colors, such as red, for cueing viewers to new information; however, developers should focus more on "bright color" in this statement than on "such as red," because red is one of the most difficult colors to see (Fleming & Levie, 1978; Pettersson, 1993). "Bright color" could also include yellow, one of the most visible colors. Again, context must be considered. A light, bright color used for highlighting would not be successful on a light background for instance.

Line

Lines carry information by way of location of point of origin, curvature, direction, length, point of change, or terminus (Fleming & Levie, 1978). Straight lines are very quickly perceived, compared to less regular and predictable lines (Fleming & Levie, 1978). Horizontal and vertical lines are perceptually "special." They are more intense (i.e., they evoke more activity in the visual cortex of the brain), are more easily compared, and are more accurately judged for spatial orientation (Fleming & Levie, 1978).

Animation

Soulier (1988) recommends using animation only when appropriate and keeping it short. In a study of the effects of visual grouping strategies with animated and static graphic presentations, Reiber (1991) found that "animation was a significant aid to learning as compared to static graphics, but only when presented as part of a series of verbal and visual chunks" (p. 12). The literature does not provide evidence that animation for its own sake increases learning. By extension of the simplicity principle that applies to graphics, simple animations are often more effective than video, although they do not have the same emotive potential as video.

Consistency

Thurling, Hanneman, and Haake (1995) discuss issues relating to consistency and use the term "cognitive overhead" to describe the process and effort required to make sense of each new screen when elements are not arranged and placed consistently throughout a program. They suggest cognitive overhead can be reduced and attention to the message increased through careful attention to consistency within all categories of screen design. Consistency of navigation and help procedures, as well as consistent location of certain classes of elements (e.g., diagrams or text blocks) is recognized to simplify the learning task (Hannafin & Peck, 1988).

Pertinent Studies

Research on the visual elements of screen design is generally divided into single-element or multiple-element studies.

Single-element Studies

The vast majority of research in the area of screen design has focused on the effects of *individual* design factors (e.g., text size). Many of the single-element studies include examples of presentation interference, although the researchers viewed their studies in terms of positive results from specific prescribed practices rather than in terms of negative effects resulting from interference. Dwyer (e.g., 1978) has extensively studied visualization and the effects of color, color coding, and realism. Several of his studies have centered on the relative effectiveness of different types of illustrations in facilitating learning. For example, in one study subject groups were shown different presentations that included the same instructional content but with different visual representations of a heart. Visuals ranged from simple black and white line drawings to realistic color photographs. Dwyer provides samples of the heart visuals used (1978, p. 56). These visuals provide an example of how interference may be unintentionally included in visual research. One of the visuals used was a color photograph of a heart, which was very clear and realistic. Another visual, a lower-quality black and white photograph of the same heart, is not realistic or even recognizable, yet the two were used to compare the differences in learning from color or black and white visuals. This example is less a comparison between color and black and white than it is an example of a poor visual interfering with delivery of a visual message. Despite the visual bias of this particular study and others like it, research on the actual benefits of color to learning remains inconclusive (Dwyer, 1978, pp. 147-150).

Knupfer and McIsaac (1990, 1991) tested retention of subject matter when text was interrupted with a graphic and varying degrees of white space. A central question of the initial study was "at what point does the amount of white space surrounding a graphic enhance or inhibit reading of the text?" The authors point out that because materials used in the studies were not professionally produced, the arrangement of text and graphics could be assumed to reflect common practice. This is quite credible and, in fact, the layout used was not unlike many arrangements found by this investigator. Specifically, a graphic was inserted within a single column of text, which made reading more challenging because the reader had to search for the next word following a break in text. As the studies showed, the more white space surrounding the graphic, the lower the gain between pretest and posttest on the material read. White space used in this way interferes with the message content (one way to remedy this type of interference is to break the single wrap-around column into two, with the text from each column wrapping around only one side of the graphic). These studies are quite useful because they illustrate how white space, generally thought of as desirable, can easily contribute to interference.

Knupfer and McIsaac (1992) conducted a similar study to examine the effects of graphics with varying degrees of shading superimposed on a text field. Subjects, divided into four groups, read displayed text and were then tested on the material they read. Subjects reading text with no graphic scored higher than those reading text with an overlaid line drawing. A third group, who read text with an overlaid graphic with 10% gray shading, scored even lower. Although the performance of these first three groups suggests support for the belief that interference negatively affects learning, a fourth group, who read text with an overlaid graphic with 40% shading, scored higher than the group presented with only 10% shading. It may be that where certain types of interference are very high and where certain motivations (e.g., immediate testing or grades) exist, subjects exert greater effort to perceive the message.

Studies of individual screen elements are important and necessary because they provide a starting point for research into screen design as a whole. Understanding the effects of individual elements enables a designer to combine them in ways that are *theoretically* effective. However, the benefit of these studies is limited because in actual practice, usually more than a single element of the overall design is flawed. Examining only one factor at a time does not represent what Grabinger (1989) refers to as the visual "gestalt." The problem is stated well by Mukherjee and Edmonds (1994): "even when it is known which elements have been combined, the overall effect of the combination is not equal to the sum of the effects of each individual element" (p. 115). Neuman (1991) further comments on a fundamental limitation of single-element research.

> Reality . . . is indivisible as well as multiple. Residing wholly in an individual's mind, reality cannot be fragmented into variables to be studied in isolation. Separating any part from the whole invariably alters both the part and the whole; studying only discrete parts therefore distorts the reality we seek to understand. (p. 41)

Necessarily, screen design works synergistically for each viewer.

Multiple-element Studies

Multiple-element screen design studies are almost nonexistent. This type of research is difficult because when individual elements are combined, effects cannot be clearly attributed to one factor or another. Grabinger (1989) found that

> Despite research into individual screen design factors, there is a dearth of research into effects of combinations of these factors. Multiple-element research tends to be more complex than single-element research. Examination of single text elements usually stops with that element and its effects on narrowly defined tasks. (p. 178)

Grabinger (1993) attempted to move beyond single-element studies by presenting many arrangements and asking viewers to select the ones they found most readable. The visuals used in the study consisted of rectangles to represent the location of graphics and "X"s to represent text. This study was neither generalizable nor realistic because the visuals had no context. "Effective" screen design is not context neutral – a screen design from an "effective" presentation cannot automatically be imposed on another topic. Results from studies by Morrison, et al (1989, cited in Morrison et al, 1991, p. 189) suggest that subjects "may apply different perspectives when evaluating screens with realistic content because of the need to process the information so that it can be recalled or applied at a later time."

An earlier study on the effects of multiple elements of screen design was conducted by Grabinger and Albers (1988, cited in Grabinger 1989) in which fourth graders were presented with CAI programs with two different screen designs. One used plain text and the other incorporated indentation, highlighting, command bars, and boxes to make the screens appear more organized and structured. The researchers found no difference in recall or retention between the two groups, but they did note a difference in the average time spent on each screen.

Time is a vital element in learning. It make sense that learning from complex or unorganized screens requires greater amounts of time. In user-controlled CAI, students are able to accommodate for different presentation styles by spending more time reading or reviewing screens that are difficult to comprehend. This extra time is not available in content-centered instruction, such as in teacher-controlled or prerecorded presentations to groups of learners. In these cases, students do not have the extra time to make up for lack of clarity, nor can they return to specific screens for review. It follows, then, that where the purpose of a study is to measure the negative effects of various screen designs on learning and retention, time must be controlled. This condition would also reflect much of the actual practice of classroom presentations. If learners do not have control over time, will they learn and retain even less of the instructional content from poor or even average screen designs than they would from interference-free screens?

Recommendations From the Literature

A clear need for comprehensive studies exists. Researchers are beginning to call for more research on the effects of combinations of individual elements. Grabinger (1989), suggests the need for researching recommendations about the best ways to combine several elements (p. 178). Haag and Snetsigner (1994) believe

> Implementing artistic principles to improve the aesthetic appeal of screens may offer a more holistic and comprehensive method of testing the impact of screen design on learners. This approach may prove a better method of investigation in this area than prior studies examining individual variables (p. 96).

Dwyer (1994) predicted that, at the college level, future research will be multifocused and will continue to explore the instructional effect of intervening variables (used singly and in combination). Research will be more comprehensive. Dwyer hopes prescriptive guidelines will be produced to help identify generic conditions necessary to maximize learning. He also suggests that different types of visuals and different types of cueing need to be comprehensively explored.

Grabinger (1993), Mukherjee and Edmonds (1994), and Haag and Snetsigner (1994) believe screen design research should move beyond single element studies. All have called for research recommendations regarding combining several elements and believe the time has come for multiple-element studies. Seels (1994) believes that, for research in visual literacy to proceed, the constructs of visual thinking, learning, and communication need to be associated with more specific operationally defined constructs.

Realistically, actual presentations will contain more than one type of flaw. Therefore, finding creative approaches toward accomplishing multiple-element research is worth the effort. The benefits of well-designed screens and the costs of poorly designed screens can only be fully understood through research that combines design elements in realistic ways. Realistic practice, including multiple design elements, should be measured against a contextually "ideal" arrangement of elements as hypothesized by combining findings from individual element studies and from professional practice. Studies on individual elements have been and continue to be important. Without them, we would not now be ready to embark on the next stage of research on screen design. With the knowledge gained from past research, we can attempt to develop interference-free screens and hypothesize about the effects of combined, flawed elements. A review of the literature suggests that research into the area of screen design should

- acknowledge the "visual gestalt"

- acknowledge the importance of context
- measure the effects of combined screen elements on learning
- have a way of determining whether some combinations of elements are more (or less) effective in aiding learning than others
- be based on treatments of visual elements previous research and practice have suggested are most effective
- lead to research-based prescriptive guidelines
- lead to operationally defined constructs that invite further research

Method

The present study incorporates the above recommendations. In addition, this study (a) includes materials designed according to professional standards that have been critiqued by experts, (b) measures subjects' beliefs regarding the content and method of delivery, and (c) contributes to a process of context-based screen design feedback to be used during and after presentation development.

Research Hypotheses

Three hypotheses were investigated during this study:
Hypothesis 1: A presentation that is intentionally presentation interference free will result in higher posttest scores than will presentations with interference. *Hypothesis 2:* As the amount of presentation interference in a presentation increases, corresponding posttest scores will decrease. *Hypothesis 3:* Subjects viewing the interference free presentation will report more positive beliefs regarding (a) the presentation, (b) computer generated presentations in general, and (c) instructors who use computer generated presentations, than will those viewing presentations containing presentation interference.

Subjects

Subjects were 118 students enrolled in undergraduate Computers in Education courses at a large Southwestern university during the fall 1996 semester. Of these, 74 (63%) are female, (86%) were within the age range of 17-29; 9 subjects were aged 30 - 39; 5 subjects were aged 40 - 49; and 2 subjects were over 50 years old. Ninety eight of the subjects (80%) were enrolled in one of three sections of Computer Literacy, an undergraduate course with some emphasis on computers in education. Twenty five subjects were enrolled in one of four sections of Computer Applications, a recommended course for students in the College of Education. Although not required of all students, both classes meet a university numeracy requirement, so they are viewed by many students as required. Subjects received extra credit from their instructors for participating in the study and were randomly assigned to one of three groups.

Treatments and Instruments

A computer generated presentation, such as an instructor could create and present using *PowerPoint* to support a speaker's presentation, was developed via *Authorware* to teach learners the various types of skin cancer and how to prevent them. The presentation included recorded narration, was designed according to known research findings and prescriptive guidelines, and was 12 minutes in length. The "control" version was free of intentional interference and passed a screen design critique by three professional presentation designers employed at a major electronic technology corporation in the Southwest.

In the second version of the presentation, two elements were intentionally manipulated in order to produce presentation interference. Treatment 2 began with the control version, with two changes: (a) background color (changed from medium blue to pink); and (b) font (changed from a basic san serif font to "Copacabana," a more ornate, display font).

In the third version, four changes were made. Treatment 3 began with the control version, to which the following changes were made: (a) background color (same as version 2), (b) font (same as version 2), (c) the addition of transition sounds, and (d) slightly off-center but consistent text and bullet placement. Although the point size for text remained constant for all three treatments, the x-height of the font used in Treatments 2 and 3 is smaller than the x-height of the font used in Treatment 1. The result is text that is technically the same size but that appears to be smaller. Thus, the net result is three types of interference present in Treatment 2 and five types of presentation interference in Treatment 3.

All the presentations were presented via Power Macintoshes with 17-inch monitors and were programmed to control the amount of time spent viewing each screen. The timing for the three presentations was identical except for the additional time required in version three by the length of the sound effects used. (The sound effects ranged in length from one to two seconds.)

A two-part instrument was used to collect data. The first part was a 25-item "short answer" and "fill in the blank" achievement test regarding the information presented. The second portion was a series of 12 seven-point, bipolar probability items. Questions 1 through 5 of the belief questionnaire referred to students' beliefs regarding the credibility and pacing of the program and how much they learned from it. Questions 7 through 9 referred to subjects' beliefs regarding computer generated presentations and the instructors who use them. Question 10 referred to the subjects' own experiences with screen design and multimedia, and questions 6, 11, and 12 referred to subjects' beliefs about their behavior before and after viewing the presentation.

Content validity was assured in the following manner: Content for both tests and instruments was based on information and photographs distributed by the American Cancer Society and the Mayo Clinic. Posttest items are parallel to the presentation. Both test and treatments were developed by a university-level presentation design instructor. Upon completion, the presentation was evaluated by three professional presentation developers in a blind critique. Both the test and the presentation were evaluated for content by the researcher, two software development teachers, and one corporate trainer.

Most internal consistency measures require multiple administrations of a test or multiple forms of the same test. A split half internal consistency procedure, which can be calculated after a single administration of a single form, was used for this study. Using the split half procedure, the reliability coefficient for the posttest was 0.82.

Procedures

Three versions of a prerecorded instructional presentation were delivered via *Authorware*. The lesson centered on the topic of skin cancer prevention. The presentation was prerecorded in order to control the amount of time spent on each screen. The control version was free of intentional interference and the treatment versions contained typical, limited combinations of interference. Data were collected during a two-week period. Subjects chose their own participation times from a variety of times offered and were randomly assigned to one of three presentation treatments. Treatments were presented via Power Macintoshes with 17-inch monitors. Subjects viewed the presentations individually, wearing headphones, under the same physical conditions, in the same laboratory, with the same lighting conditions, and received extra credit for participating in the study. The duration of the presentation was 12 minutes. All subjects completed the questionnaires immediately following the presentation and were allowed as much time to complete the posttest and questionnaire as they desired. Completing the questionnaire required between 10 and 20 minutes. All posttests were scored by the same grader and rechecked for accuracy by another instructor. The number of points correctly answered on the posttest was converted to a proportion of the items possible.

Design

In order to determine the effect of presentation interference, an experimental posttest only control group design was used (Figure 4). The posttest only control group design with random group assignment controls for all sources of internal invalidity except for mortality (Gay, 1992). Mortality was not a serious threat to this study because of the short data collection period. Variables such as age, computer anxiety, grade point average, etc., were controlled for by random assignment to treatment groups. An interference free presentation was used as the control treatment with results being compared to those of two additional treatments containing presentation interference. The independent variable was treatment (presentation version). The dependent variables were (a) the proportion of correct responses to the follow-up test and (b) responses to the belief questionnaire. Data were analyzed using analysis of variance (ANOVA), Fisher's Least Significant Difference (LSD) post hoc analysis, and calculation of effect size.

Results

Hypothesis 1

A presentation that is intentionally presentation interference free will result in higher posttest scores than will presentations with interference. Treatment 1 did result in a higher mean score on the follow-up test than Treatments 2 and 3. An analysis of variance (Table 1) shows that a significant difference in posttest scores exists by treatment, $\underline{F}(2, 117) = 4.575$, $\underline{p} = .012$.

Table 1. Analysis of Variance of Posttest Scores by Treatment

SOURCE	SS	DF	MS	F
TREATMENT	0.145	2	0.072	4.575 *
ERROR	1.822	115	0.016	

* p = .01

Fisher's Least Significant Difference reveals that the difference between that the posttest means of Treatments 1 and 2 (.083) is significant (p = .004), with a moderate effect size of .55. The difference in posttest means between treatments 1 and 3 (.064) is also significant (p = .027) with a moderate effect size of .43.

Hypothesis 2

As the amount of presentation interference in a presentation increases, corresponding posttest scores will decrease. Group means by treatment are displayed in Table 2. As expected, Treatment 2, with two types of interference, resulted in lower posttest scores than did Treatment 1, with no intentional interference. However, contrary to the hypothesis, Treatment 3, with the most presentation interference, did not result in a significantly lower posttest scores than Treatment 2.

Table 2. Posttest Means by Treatment Group: Percent Correct

	Treatment		
	1	2	3
Learning Cost	.86	.80	.82
N	37	41	40

Hypothesis 3

Subjects viewing the interference free presentation will report more positive beliefs regarding message content and delivery method than will those viewing presentations containing presentation interference. All subjects completed a 12-item belief questionnaire. Responses were collected via a seven-point bipolar probability scale. For items 1 - 10, 7 = "Strongly Agree" and 1 = "Strongly Disagree;" for item 11, 7 = "Extremely Concerned" and 1 = "Not at all Concerned;" and for item 12, 7 = "Extremely Often" and 1 = "Not at All." It was hypothesized that subjects in the control group (Treatment 1) would respond more positively to the items on the questionnaire than would subjects in groups two or three. Table 4 presents the questionnaire items and mean responses.

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Table 3. Mean Responses to Belief Questionnaire

#	Item	T1	T2	T3	F
1.	I thought the presentation was believable and authoritative.	6.76	6.46	6.60	1.76
2.	I learned a lot from this presentation.	5.70	5.49	5.68	.47
3.	I thought the presentation was too fast.	2.27	2.34	2.23	.07
4.	I thought the presentation was too slow.	2.87	3.07	3.20	.41
5.	I thought the presentation was paced just about right.	5.46	5.42	5.38	.02
6.	I expect some of my behaviors to change as a result of viewing this presentation.	4.60	4.27	4.75	.79
7.	In general, computer-generated presentations are very beneficial.	6.16	5.66	6.40	4.92 *
8.	Instructors who use computer presentations are usually better than those who do not.	4.25	3.98	4.65	1.57
9.	I trust and respect teachers who use computer presentations in the classroom more than I trust and respect those who do not.	3.16	2.61	3.50	2.86
10.	I have had lots of experience with screen design and multi-media production.	2.54	2.22	2.68	.73
11a.	Before viewing the presentation, I was concerned about my getting skin cancer.	3.38	3.60	3.46	.18
11b.	Now, after viewing the presentation, I am concerned about my getting skin cancer.	4.97	5.24	5.13	.31
12a.	Before I viewed the presentation, I applied sunscreen this often:	3.08	3.17	3.10	.03
12b.	After viewing the presentation, I expect to apply sunscreen this often:	5.00	4.78	5.05	.32

Subjects in all groups thought the presentation was believable and authoritative, with mean responses for item 1 ranging from 6.46 to 6.76 of 7.00 possible. Responses across all groups were also positive for item 2, "I learned a lot from this presentation," with mean responses ranging from 5.49 to 5.7 of 7.00, and for item 5, "I thought the presentation was paced just about right," with mean responses ranging from 5.38 to 5.46 of 7.00.

For items 6, "I expect some of my behaviors to change as a result of viewing this presentation," and 8, "Instructors who use computer presentations are usually better than those who do not," responses were uniformly neutral across treatment groups. For item 9: "I trust and respect teachers who use computer presentations in the classroom more than I trust and respect those who do not," responses were slightly negative and the difference between treatment groups was not significant ($p = .06$). Responses to item 10, "I have had lots of experience with screen design and multimedia production," were uniformly low across treatment groups (2.57, 2.22, and 2.68, respectively, on a scale of one through seven with one being "strongly disagree").

Analysis of variance revealed that the difference in mean treatment group responses to item 7: "In general, computer-generated presentations are very beneficial" was significant ($p < .01$), as shown in Table 4. This item directly addresses one of the primary questions of this study. Means by treatment for item 7 are shown in Table 5. Group 3, which received the treatment with the most types of interference, had the highest mean response to this item (6.4), followed by groups 1 and 2 (6.2 and 5.7, respectively).

Because significance was found using ANOVA, LSD post hoc tests were performed amongst all treatment means. The difference between treatment groups 1 and 2 regarding item 7 was significant ($p = .043$) with a low effect size of .35. The difference between treatment groups 2 and 3 was also significant ($p = .003$), with a moderate effect size of .52. There was no significant difference in mean response between Treatments 1 and 3 ($p = .339$).

Table 4. Analysis of Variance of Item 7, Computer Presentations Beneficial

SOURCE	SS	DF	MS	F
TREATMENT	11.611	2	5.806	4.915 *
ERROR	135.847	115	1.181	

* $p < .01$

Table 5. Treatment Means for Item 7, "Computer-generated presentations are beneficial"

	Treatment 1	Treatment 2	Treatment 3
Agreement	6.2	5.7	6.4
N	37	41	40

Responses to items 11 and 12 did not vary significantly by treatment, nor was there any significant difference between treatments regarding the gain from item 11a to 11b or from item 12a to 12b. Note that items 11 and 12 did not deal directly with presentation-related issues, rather they focused on individuals' concerns and habits regarding their own health and skin care habits.

Three hypotheses were investigated in this study. The first, whether Treatment 1 (no intentional interference) would result in a higher mean posttest score than either Treatment 2 or Treatment 3, is supported by the results. The difference between Treatments 1 and 2 was significant ($p < .01$). The difference between Treatments 1 and 3 was also significant ($p = .02$). The second hypothesis, that increases in the amount of interference would result in lower posttest scores, was not supported; There was no significant difference in learning cost between Treatments 2 and 3.

The third hypothesis, that the presentation with no intentional interference would result in more positive responses to the belief questionnaire are supported in part. Treatment 1 did result in a significantly more positive mean response to item 7 ("In general, computer generated presentations are very beneficial") than did Treatment 2, as expected. However, Treatment 3, with the most intentional interference and which was expected to result in less positive responses than either Treatments 1 or 2, also resulted in a significantly more positive mean response than Treatment 2. There was no significant difference between Treatments 1 and 3 regarding item 7.

Discussion

Presentation Interference

Interference Versus No Interference

Hypothesis 1 predicted that a presentation without intentional interference would result in higher posttest scores than would those containing presentation interference. Comparing group means for the interference free presentation with each of the two interference presentations revealed that the posttest scores for the interference free presentation group were significantly higher than those of either of the two groups receiving presentations containing interference. This is not surprising in light of existing single element research and studies that unintentionally included interference (e.g., Dwyer, 1978). Unlike Grabinger and Albers' (1988, cited in Grabinger 1989) study, subjects in this study did not have control over the amount of time allowed for each screen, a pacing condition closer to that in which an instructor lectures with a *PowerPoint* presentation, and controls the pace. Subjects' responses to pace-related questionnaire items indicate that the pacing in the present study was adequate for all three treatment groups.

Interference Versus More Interference

Hypothesis 2 predicted that increasing the amounts of presentation interference would result in lower posttest scores. This hypothesis is partially supported. Between groups 1 and 2, the significant difference ($p = .004$) in posttest scores is attributed to the presence of presentation interference. Treatment 2 contained two intentional changes from Treatment 1. The background color changed from blue to pink, and the font changed from a basic san serif font to a more ornate display font that appeared to be smaller. Two types of interference were intentionally introduced, yet the net result was at least three types of interference because the visual size of, for example, "48 points," is not identical from font to font. The apparent size difference from identical point sizes supports Mukherjee and Edmonds (1994) point that the whole is greater than the sum of the parts, and illustrates why a prescriptive that computer delivered text should be "at least 26 points" (Gibson & Mayta, 1992, cited in Knupfer, 1994) can be meaningless or misleading. Past single element research attributed differences in learning to the change of a single element. While manipulation of only one element makes cause and effect easier to ascribe, the value to actual practice is limited because screen designs are made up of multiple elements that often have more than a single flaw. As the present multiple element study demonstrated (e.g., point size versus apparent size), single intentional element changes can have multiple apparent effects. The difference between treatment groups in the present study is not entirely attributable to any single element (e.g., background color) because the purpose and design of the study required multiple element manipulations. The focus of this study was not to determine which kinds of interference are worse than others, but to determine whether the presence of interference in realistic combinations had a significant effect on learning from a computer generated presentation. The study also sought to determine whether increasing the interference present in a presentation would increase the difficulty in learning.

There was no significant difference between Treatment 2 with three types (including the apparent text size) of interference and Treatment 3, with five types (including the apparent text size) of interference. This may be partially explained in terms of Thuring, Hanneman, and Haake's (1995) concept of "Cognitive Overhead." Cognitive Overhead increases when learners must become reoriented with inconsistent design elements in a presentation. For example, the first intentional change in Treatment 3 from Treatment 2, the minor misalignment of bullets and text, would not be considered to add to a learner's cognitive overhead after the first occurrence because their misplacement remained consistent throughout the presentation. According to the concept, a presentation in which the bullets and text on alternating screens was aligned and misaligned would increase the cognitive overhead to a greater extent than would consistent misalignment throughout an entire presentation. If the misalignment in this study was noticed, it may have become less noticeable or important to learners as the presentation progressed. Reducing inconsistencies should reduce cognitive overhead. In this regard, cognitive overhead and presentation interference are similar in that they both refer to negative effects within specific contexts (as opposed to supposed context-free universal prescriptives).

The second intentional difference in Treatment 3 from Treatment 2 was the screen transition sound effects. The sound effects had no topical relevance to the material being presented and were expected to distract learners from the message content. However, results showed no significant difference between Treatment 2 and Treatment 3. Participants, wearing headsets, viewed the presentations via Power Macintoshes in a busy, open-use computer laboratory. During data collection the lab was in nearly normal use. Although the computers not being utilized for the study had messages taped to the monitors requesting that users work quietly, there were consistent, typical noises and distractions. All three treatments included audio narration for each screen but Treatments 1 and 2 were silent during screen transitions, allowing ambient noises and distractions to be available to participants. Only Treatment 3 had sound effects and, although they were intended as a distraction, they may have minimized the distractions from others working in the crowded computer laboratory and kept learners' attention on the presentation. There is no evidence from this study that the sound effects either aided or hindered learning.

Results suggest that intentionally increasing interference does not necessarily lead to lower posttest scores. Further, elements that can be reasonably expected to result in interference may, in some contexts and settings, have positive or neutral effects. In a particular setting and context, there may be a threshold at which additional interference results in compensation by learners. The phenomena of higher achievement from what could be reasonably expected to be more difficult screens is evidenced in the literature (e.g., Knupfer and McIsaac, 1992). Cermak and Craik (1979, cited in Pettersson, 1993) found that when learners perceive a task as more demanding, they process the materials more deeply and better remember both details and main ideas. This is also suggested by research conducted by Grabinger (1989). However, busier or more elaborate displays do not necessarily improve learning. According to Hannafin and Hooper (1989),

> Although the student may be more aroused by visually stimulating displays, and important details may be illuminated by improving legibility, such displays may also increase the processing burden on the learner and cause shallow processing of important lesson content. (p. 156)

Beliefs Regarding Computer Generated Presentations

Hypothesis 3 stated that subjects viewing the interference free presentation would respond more positively to belief statements regarding message content and delivery method than would those viewing presentations containing presentation interference.

Overall, subjects responded positively to all three versions of the presentation. The only significant differences in subject responses to the belief questionnaire were to item 7, "In general, computer generated presentations are very beneficial." Subjects from all three groups agreed with this statement, however the responses from group 1 (with no intentional interference) and group 3 (with the most intentional interference) were significantly higher ($p = .043$, $p = .003$, respectively) than those from group 2. The significant difference between Treatments 1 and 2 was expected but the fact that Treatment 3 resulted in a higher mean response than Treatment 2 was not.

This may be explained in light of findings from a survey reported by Sammons (1995) of 500 students in 15 university classes in which computer generated presentations were used. Results from that survey indicated that although students generally liked the use of computer aided presentations in classrooms, according to Sammons, many students thought that the computer was not being used to its advantage and that "using a computer as a glorified overhead projector is a waste" (p. 68). Common comments regarding the screen designs of instructor developed presentations were the following:

> 1. Letters are often not large enough or legible.
> 2. There is not enough color contrast.
> 3. Too much information appears on each screen. Students suggest including only key points.
> 4. Students prefer an outline format with a hierarchy of points and subpoints rather than bullets all at one level. (p. 68)

Considering Sammons' study in which subjects believed that classroom presentations did not use the computer to its advantage, one might infer that subjects in group 3 (with transitional sound effects) may have perceived that the presentation took advantage of the computer's options. The difference between treatment groups 1 (no interference) and 3 (the most interference) regarding item 7 was not significant. Subjects in group 1 felt strongly that presentations are beneficial. That belief was supported by their performance on the posttest. Subjects in group 3 believed as strongly as those in group 1 that presentations are beneficial, but they performed significantly worse on the posttest than did subjects in group 1. Treatment 3 did result in positive beliefs about the medium but did not result in improved learning. Results indicate that although subjects who view well designed presentations and those who view presentations containing interference may both report strong beliefs regarding the beneficial nature of computer generated presentations, presentations containing interference significantly reduce learning.

Subjects generally agreed with item 8, "Instructors who use computer presentations are usually better than those who do not," with neutral means (3.98–4.65 out of 7) across groups and no significant difference between treatment groups. Responses to item 9, "I trust and respect teachers who use computer presentations in the classroom more than I trust and respect those who do not," were slightly negative for all groups (2.61–3.5 out of 7).

Implications of the Study

Presentation Interference is a viable construct for use in screen design development and research. Previous research on screen design was driven by the search for identifiable individual element prescriptives to be used in an additive process. Research has shown that manipulating single elements can affect learning (e.g., Aspillaga, 1991, Winn & Solomon, 1993). However, presentations do not consist of only a single element and the combination of single elements results in a new whole. Moreover, a set of specific universal visual design formulas cannot possibly be appropriate to every context. Design prescriptives derived from single-element research are a useful and logical starting point but several researchers (e.g., Grabinger, 1989; Hannafin & Hooper, 1989: Haag & Snetsigner, 1994; Mukherjee & Edmonds, 1994) agree that they are not enough. In addition, presentation development should include cognitive strategies (e.g., Hannafin and Hooper, 1989), and a followup evaluation process to eliminate presentation interference. Looking for and eliminating interference is always context-based.

This study supports the assertion that screen design flaws, in this case, relatively conservative ones, can negatively affect learning. The purpose of this research was not to quantify or categorize interference in order to devise universal rules regarding the "right" way to use elements. Quantifying design choices is of limited value.

In practice, no designer would knowingly leave one poorly executed element in because another was "worse" according to research. A label such as "inappropriate design choice" is only meaningful in relation to the particular context in which the choice is inappropriate. The goal is not to choose one type of interference over another, but to eliminate interference altogether.

The concept of presentation interference is not intended as a replacement for any of the existing screen design constructs. The process of identifying and eliminating presentation interference is intended to augment the design process as a context relevant way to evaluate and improve existing presentations and to evaluate whether or not constructs such as comprehensibility and readability have been achieved.

Continued emphasis on single element research will not allow for practical exploration of the visual gestalt. Researchers are not likely to get beyond two or three elements if they must measure every single element and every multiple element combination by degrees to get to the point of realistic combinations. The present study looked at interference created by inappropriate use of four (or arguably, five) elements. In order to look at the combination of only four types of interference and be able to quantify and attribute the effects to individual elements or specific combinations, 15 treatments would have to be developed (1 control + 4 single + 4 + 3 + 2 + 1 = 15). Using the generally accepted guideline of a minimum size of 30 subjects for each experimental treatment group (e.g., Gay, 1992), at least 450 subjects would be required. Conducting or replicating such a study is extremely impractical and, even if it were not, the use of such quantifiably categorized single elements would be of strictly limited use.

Strengths and Limitations

This study began with a contextually appropriate arrangement of elements to present realistic content. Presentation design decisions were context based. Expert development and feedback regarding the design of the presentation were used to establish the interference free control treatment. The interference free control treatment was measured against treatments with realistic combinations of interference. This allowed a more meaningful result than would comparing two treatments that both reflected realistic practice. The study used a holistic approach and acknowledged the visual gestalt by including multiple flawed elements, in realistic combinations, in a presentation with real content. Replication could be expected to find similar, general kinds of results but not identical findings because exact contexts will not be duplicated.

Limitations of this study that may affect validity or include the age of subjects and their voluntary participation, although the effects of the latter factor were reduced by randomization. Students in this study participated individually with headsets. In a crowded lecture hall, sitting with friends and fellow students, sound effects may have an entirely different effect.

Recommendations for Future Research

Several suggestions from this study are deserving of further research:

Replicate this study with these and other types of interference in presentations based on different content and contexts but with similarly rigorously prepared interference

free control versions. The importance of beginning with a contextually based ideal, which can then be measured against realistic practice cannot be overstated. The context based interference free control treatment can be measured against presentations based on the control version to which combinations of presentation interference have been cumulatively increased (e.g., three, five, and seven intentionally added examples of interference).

Conduct research to investigate whether at some point, the addition of more interference does not increase learning cost. This should be investigated, not in an effort to quantify or categorize types of interference, but to see if learners can compensate for extra interference with extra effort. If such a point exists in replication, context dictates that point will necessarily be different for every study.

Revise the belief questionnaire to include items such as "Learning from this presentation was easy" or "This presentation required concentration."

Conduct research with similar treatments but expose each entire treatment group to the corresponding presentation at one time in a lecture hall. While this may be difficult practically, the method may reveal different responses to transitional sound effects than resulted from individual participation with headphones.

Consider adding a later followup test to measure whether there is a difference in recall over time.

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Wait 'till ya hear this one: Professional Development Through Anecdotes

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This paper is part of a larger their practice of teaching mathematics to be consistent with reform initiatives, and 2) investigating a model of professional development that addresses problematic issues for the teachers. For us, as instructional designers investigation that has the dual goals of: 1) determining problematic issues for teachers as they change and developers, the problematic issues addressed though the professional development process are not as important as how the teachers' knowledge is generated and shared; thus I will focus on the second goal of our investigation. This paper will describe the evolution of our model of professional development as we explored techniques to incorporate technology to provide social support for changed practice.

Nature of Professional development

The professional development of practicing professionals often involves modifying or expanding upon deeply seated ideas and beliefs about the way their business should be conducted. Teachers embark on the mission of teaching with implicit and explicit beliefs about the way classrooms should be managed and content should be taught. These beliefs may be implicit or explicit, but they are the summation of a variety of factors including prior experiences with their own teachers, knowledge gained from coursework or independent reading, and perceptions of themselves in the role of teacher (Kagan,1992). As such, the professional development of individuals with experience in a given area of practice may require that they reconceptualize their professional roles and responsibilities (Goldsmith & Schifter, 1993).

Most attempts to change the practice of experienced teachers have consisted of experts training teachers in new practices (Feldman, 1996). "While these types of inservice education can be effective, they make little use of the expertise of the teachers being inserviced." (Feldman, 1996, p. 513). The challenge for me as an instructional designer was to develop teacher education activities that worked with the teacher, rather than worked on the teacher. Our intent was to create "instruction" that would provide opportunities for teachers to identify issues that were relevant to them and to enhance their practice in areas that were personally meaningful to them.

In addition, we wanted our approach to professional development to be consistent with the theoretical basis of their classroom curriculum. Based on a Piagetian approach to learning, conceptual change occurs through experiences that induce cognitive conflict and indicate inadequacies in current thinking (Piaget, 1985). Learners should be actively involved in trying things out to see what happens, posing their own questions and seeking their own answers, reconciling what was found at one time with what was found at another, and comparing their findings with those of others (Driscoll, 1994). Through the processes of assimilation and accommodation teachers may reconceptualize their roles as teachers (Goldsmith & Schifter, 1993). Through assimilation, new ideas are incorporated into existing schemes; through accommodation, existing ideas are modified to account for new experiences. New ideas must be consistent with learner's experience in order to be acceptable to the learner; modified ideas must account of all new and previous data. In addition, interactions with peers are an important source of cognitive development; through social interactions, as well as through action, learners can become dissatisfied with their existing knowledge. Through comparing their ideas with the ideas of others, learners may find new ideas that are plausible and useful alternatives to their current conceptions (Goldsmith & Schifter, 1993). We wanted to create opportunities for teachers to express and examine their beliefs, values, and practice, and to compare those personal beliefs, values, and practices to those of others.

In addition, many skills needed by these professionals are "ill-structured" (Jonassen, 1997). Ill-structured problems are those for which multiple opinions and perspectives exist; in order to find a solution, reflective judgments must be made about the advantages and disadvantages of a particular solution for different people and contexts. Often there is no "right answer" to dilemmas they may face, only a collection of possible solutions or options.

Cases for professional development

Case-based instruction can provide opportunities for conceptual change to occur and meet the conditions for teaching in ill-structured knowledge domains (Driscoll, 1994; Jonassen, 1997). Cases provide a context through which learners can explore dilemmas and solutions. They can be a description of a real event, a modification of a real event, or a fictional event. Typically, a case discussion begins with the presentation of the case, a discussion of what is know and not know (relevant facts of the case), and discussion of possible interpretations and solutions to the case dilemma.

They are particularly useful for novices in a content area (preservice teachers, for example) in that they provide a point of reference. Often preservice teachers are unable to imagine what it would be like to be a teacher. They lack a frame of reference to which to apply the new knowledge gained in coursework. They emerge from their education with an idealized view of teaching. And when faced with the complexity of the classroom environment, may abandon what they learned and instead, react by teaching in the way they were taught. They may be unable to resolve conflicts between what they have learned about teaching in their university classes and what they know about teaching from their prior experience, in face of the realities of the classroom.

Experienced teachers enrolled in professional development activities, on the other hand, already have a current frame of reference in which to consolidate their new knowledge. They are acutely aware of the realities of the classroom. We wanted to find a way for practicing teachers to explore new ideas about teaching consistent with reform initiatives and consolidate new ideas with their knowledge gained through practice and the "apprenticeship of observation" (Lortie, 1975). In addition, we wanted to provide social support for changed practice in an arena where teachers could capitalize on their own experiences and those of their peers to explore issues relevant to reform-based teaching of mathematics. And finally, we wanted to provide an opportunity for them to extend their modified ideas to their classrooms.

Anecdotes for Professional Development

Similar to cases, anecdotes of teaching episodes have provided a means for teachers to work on their practice in a variety of content areas (Feldman, 1996; Joworski, 1989; Mathematical Association, 1991; Stock, 1993). An anecdote is "a narrative of a detached incident, or of a single event, told as being in itself interesting or striking" (Oxford English Dictionary, 1971, as cited in Feldman, 1996). Like cases, anecdotes situate "specific teaching-learning moments in the material circumstances in which they occur" (Stock, 1993, p. 185).

In her discussion of the use of anecdotes to examine teaching and learning in English classrooms, Patricia Stock (1993) proposed that teachers continually develop their understanding as they recreate the anecdote through successive retellings. "That teachers tell anecdotes when discussing their teaching is common knowledge. What is not generally recognized are the functions that the shaping, reshaping, and rehearsing of anecdotes play in the research we informally and- I would claim- systematically conduct into our practice" (Stock, 1993, p. 184). By drawing attention to specific incidents in their teaching, teachers invite others to join them in attempting to make sense of the incidents in order to improve their practice (Stock, 1993).

Allan Feldman (1996) also determined that anecdotes played a significant role in teachers' research into their own practice. He convened a group of eight physics teachers to engage in collaborative action research on their practice. The group meet for one and a half hours approximately every three weeks for two years. Feldman audiotaped the sessions to examine "the ways that teachers' knowledge about teaching and their educational situations grow when they are engaged collaboratively with other teachers in inquiry on their own practice" (Feldman, 1996, p. 513) Upon analysis, he found three practices pervading their work together: anecdotes, trying things out, and systematic inquiry.

The role of the anecdote was critical throughout all three processes. Often, teachers would relate an anecdote. Others would respond in one of three ways: by telling a related anecdote, by asking for details of what was described in the anecdote (who, what, where, how, and when), or by asking questions that would provide them with a better understanding of the situation described in the anecdote (why something occurred). When teachers decided to "try something" new, they often tried something that had been described in another teachers' anecdote. When the teachers "tried something" new, they often reported the incidents to the group as anecdotes. And when teachers engaged in systematic inquiry, a narrative analysis of their classroom practice seemed more powerful to them than following traditional scientific methods. The teachers treated the narrative analyses and accompanying data the same way they treated the anecdotes: through relaying other anecdotes, through asking for details, or through questioning for meaning.

Feldman (1996) believed each of these responses to an anecdote was of value to the participants. When teachers responded to an anecdote with another anecdote, the additional anecdotes added context and begin to "indicate to others how their knowledge is related to the situations of the tellers" (Feldman, 1996, p. 522). When they responded with questions that asked for details, "they were seeking information that would help make the knowledge and understandings presented in the anecdotes more useful" to their own experiences (Feldman, 1996, p. 522). And finally, questions that focused on the understandings that the anecdote tellers had of their situations shifted the focus from the specific details of the anecdotes to interpretations of the events that were relayed in the anecdotes.

These stages in responding to anecdotes are similar to the stages Barbara Jaworski (1989; Mathematical Association, 1991) has outlined for working with anecdotes for professional development. In her workshops with mathematics teachers, she presents an anecdote, either written or on videotape, and has the teachers move through a structured approach of providing an *account of* the events in the anecdote, followed by *accounting for* the events. In her workshops, groups of teachers

- view or read an anecdote (relay anecdote)
- construct an *account of* what they saw or read (clarify details)
- try to *account for* what was seen or read (interpret). In accounting *for* their interpretation of the anecdote, they share related episodes in their own teaching as examples (share anecdotes).

The work of these researchers and teacher educators indicates that anecdotes can provide a concrete reference for practicing teachers, a way of envisioning how ideas would work in their own classrooms. In addition, as a means of professional development, anecdotes rely on the expertise of the teachers and their ability to construct and share knowledge and understanding. Thus, we chose to extend upon the work of these researchers in several ways. We wanted to ensure that the teachers would extend the ideas examined during our professional development activities to their practice. In addition, we wanted to provide opportunities for the teachers to work on their practice over an extended period of time.

In addition, we believed that a video-based professional development program could support in-service teachers as they experimented with new curricular and/or teaching approaches. Common approaches to using videotape include the use of video to construct case studies of exemplary teaching practice. But although video-based demonstrations of "expert" teachers may encourage replication, it does not encourage exploration of issues of personal interest. We wanted to investigate ways that learning environments can be designed to be customizable by teachers and how videotapes can be used to provide opportunities for teachers to link new ideas to their own practice. Building from our examination of the use of anecdotes for professional development of practicing teachers, we explored a video-based approach to professional development using anecdotes.

Context of our investigation

Large-scale K-12 mathematics curriculum reform efforts have been underway for several years (National Council of Teachers of Mathematics, 1989). As curriculum is reconceptualized to emphasize project-based approaches to the development of understanding, the role of the teacher is changing. These changes require a skills in facilitating and coordinating learning experiences for individuals and groups of students; teachers need to conduct active, productive discussions of mathematical ideas.

This professional development program is targeted to teachers who desire to recreate their practice in manner consistent with mathematics reform initiatives. The teachers may be in their first year of practice, or may have many years of teaching experiences. However, all are attempting to modify their practice consistent with reform initiatives. As teachers will voluntarily choose to develop their skills in reform based mathematics teaching, we assume that teachers will be convinced of the value of giving students responsibility for their own learning prior to becoming interested in this professional development program. It is possible that the teachers may have experienced previous frustrations when teaching in this manner. However, we are assuming that the teachers are motivated to succeed and confident that they could successfully develop their practice . Typically, teachers place high value on the learning of their students. Thus, we believed the initial activities should demonstrate the value to the students of adapting alternative methods of teaching mathematics. In addition, we assumed the teachers would like to quickly apply what they learned to their classroom context.

As an instructional design and development team, we began our conversations with discussions of what kinds of "changes in thinking" we wanted to see in the teachers. We knew there were differences in teachers' practice in mathematics class, even though all the teachers all were using the same problem-based math curriculum . However, we were unsure of the nature of these differences.

As we had no answers, we moved to a discussion of how we would know that changes in thinking had occurred. We decided to analyze videotapes of classroom mathematics lessons to identify differences in practice among elementary mathematics teachers. Using a data resource which consists of approximately 200 videotaped lessons collected over a period of one year in five second-grade mathematics classrooms, we developed a classroom coding scheme, coded, and interpreted the teacher's and students' actions (Wood, Turner-Vorbeck, & Walker, 1996b).

Differences in teacher's practice

Through detailed analysis of videotapes of classroom practice, we identified three dimensions around which teachers' practice varies (Wood, Turner-Vorbeck, & Walker, 1996a; Wood, Walker, & Turner-Vorbeck, 1996).

- Although all the teachers had their students vocalize their way of thinking about mathematics, the teachers varied in the meaning they hold for "children's thinking". Some teachers had students report their solutions to the problem, others required them to tell how they solved the problems, and others asked students to tell why they did what they did .
- Teachers also varied in the extent to which they allowed disagreement: some set up exchanges that were primarily between teacher and student; others established exchanges between students and the rest of the class.
- We also discovered that when children shared their ideas, teachers varied in their expectations for active participation by the "listener" and "explainer".

From this analysis, we developed a theoretical framework that clarifies issues that may be important to teachers as they develop their mathematics teaching. We identified three types of context created in classrooms that influence students' opportunities to engage in mathematical thinking and reasoning: reporting of solutions, inquiry into the solutions, and argument about the solutions. These contexts are a result of ways in which teachers establish with the children the social norms or expectations for behavior in mathematics class. As teachers and their students move vertically throughout the model, students move from reflective thinking to critical reasoning; as they move horizontally, students take greater responsibility for learning. Having identified issues around which practices vary, our challenge was to develop activities that allow the teacher to explore these issues in their classrooms in personally meaningful ways.

Development of the plan

Simultaneously, with our analysis of classroom videotapes, we begin to develop our way of working with teachers. Using the work of Barbara Jaworski and the Open University(1989; Mathematical Association, 1991) as a guide, we developed a tentative way of working with teachers to promote reflection on the practice of mathematics teaching.

In the Spring of 1996, we tested our way of working with seven teachers who participated in ten two-hour teacher development sessions. In these sessions, teachers selected video segments from their own classrooms to illustrate issues of importance to them. Although we had developed a tentative pattern for discussion, we continually reflected on and modified our way of working throughout the sessions to determine the sequence and questioning approach that was most effective in generating discussions of multiple solutions to problems and issues. As we conducted these sessions, we recorded our expected actions for the session prior to the session, videotaped the sessions, recorded field notes, and made reflective notes following the session. The videotapes were logged for analysis. The participants also recorded their reflections and assignments in a notebook. We analyzed these data to identify patterns of behaviors and responses, to determine if the issues teachers identified as important in their classrooms were similar to the issues we identified as important based on our analysis of classroom videotapes, and to refine our way of working with the teachers. After our analysis revealed that the problematic issues that arose from the teacher sessions were consistent with those we had identified from our analysis of classroom videotapes, we felt confident in developing video segments to focus discussions on identified issues.

The plan

From our analysis, we developed a set of videotapes and supporting leader's guide for professional development of elementary mathematics teachers. The materials consist of a series of five videotape segments of mathematical discussions as they occurred in elementary classrooms. The videotapes are supplemented with a "leader's guide" that outlines our way of working with anecdotes. The leader's guide includes statements that should be made to the participants and notes to guide the discussion of the sessions. However, the teacher leader is not the authority in the session, only the moderator, who is charged with moving the discussion forward, to moving beyond anecdotes to identification of issues and plans for action. The leaders role is one of chairing the session. He or she should ensure that all participants get a chance to voice their opinions and thoughts and should mediate so that all may have an opportunity to do so. The leader's guide contains video notes, which indicate possible issues that may arise from the videotaped segments, or possible paths the discussion may take.

As planned, the professional development sessions we conducted with teachers were to follow the steps outlined below:

1. Share an anecdote. We initially prepared a set of five videotaped "anecdotes". These anecdotes were segments from actual elementary mathematics classes. The segments were selected because they illustrated a particular "block" in our framework. However, we recognize that classroom events are complex; and that each segment could be interpreted from a different perspective than the one for which it was selected to represent. The materials allow for this flexibility. The teacher working sessions begin by showing a videotape anecdote, corresponding to one "block" in our framework.

2. Reconstruct the details of what was seen on the videotape. After viewing the videotape, individuals mentally reconstruct the events of the videotape. Participants spend about five minutes working in pairs to agree on what was seen on the tape, then join together as a whole group and spend about ten minutes discussing what was seen on the videotape.

3. View the anecdote again and think of related anecdotes. Participants watch the videotape a second time, paying attention to what the students may be thinking as they are participating. As the group discusses the events from the perspective of the student, they consider what the child talking thinks he or she is expected to do and what the children listening think they are expected to do. Participants reflect on how the actions of the students are similar or different from what happens in their classroom. They are asked to think of one small event from their own classroom that relates in some way to the events of the videotape and record their reflections in their notebook. The video simply provide a shared classroom experience from which discussions of individual issues could begin. The most important aspect of the discussions involves participants examining their own situations.

4. Distill or interpret the issues. In pairs, participants exchange ideas of how the discussion is similar or different from what they observe their own students doing and saying in their classroom. Then pairs try to identify the themes that lie behind their experiences. The entire group joins together and spends 15 or 20 minutes discussing the theme or issues that pairs identified in their discussions. General statements and interpretations should be illustrated with "for instances" from their own experience. Using participant's own experiences as "for instances" grounds their statements in their practice, illustrates ideas more clearly, and encourages participants to reflect on their own practice.

5. Identify a personal plan. Participants spend a few minutes individually reflecting on specific action that they may want to try out in class to further explore the issues they identified as important. Actions may include looking out for occasions when certain things happen, trying some new approach, or making some small changes in behavior. Then participants join together as a group and spend about ten minutes sharing their ideas for action. Participants are directed to consider the issues identified and possible action steps, and individually think about their expectations for future math discussions in their classrooms.

6. Take to practice. Participants videotape one or more class sessions to document events in their classrooms. Before they videotape their classes, they are to list their expectations for themselves and their students in their notebook. After they videotape the class, they are to review the videotape and compare their expectations to the actual events that occurred in the classroom, recording their reflections in their journal.

7. Repeat the cycle with individual teacher's tapes. When the teacher development group reconvenes, each teacher brings his or her own videotape and anecdotes of classroom events to share with the other teachers. The process of working with videotaped anecdotes is repeated with individual teacher's tapes until the group decides to move to another issue.

Findings

We begin to use our "way of working" with a group of teachers in the Fall of 1996. Through the last 18 months, we have made the following observations:

Things don't always proceed according to plan

Although we initially used a video "anecdote" as a means of initiating discussion on similar events in the teachers classroom, and followed our way of working with videotaped anecdotes, we found that as soon as teachers begin videotaping in their classrooms, we never returned to viewing the prepared tapes. Teachers were enthused about bringing in their own tapes to discuss with the group, and wanted to continue in this way. One issue lead to another, and recognizing teachers desire to work on their own classroom, we allowed them to continue in this way.

In addition, we found that this second group of teachers seemed to need to focus on what the students were thinking. We recognized from the beginning that teachers were more comfortable focusing on the children's responses than focusing on the actions of the teachers, but believed that they could quickly make the connection between what the children were thinking and the classroom norms established by the teacher. We found that was not true: they were simply unable to judge what children were thinking from their responses to math problems.

Thus, the focus of our discussions and videotapes that were shared shifted from an examination of teacher's behavior to a focus on children's mathematical thinking. We realized that this group of teachers lacked an essential prerequisite for focusing on the issues we had identified. Our initial set of videotapes was created to be a rich environment where anecdotes of classroom events could be examined from many different perspectives. However, once the focus of discussions shifted to an examination of children's thinking, we found we had no videotapes appropriate for the altered focus. We depended on teachers to bring in tapes of their own to examine as a group.

With experience, stages in the process merge, alternating between examining details, relating anecdotes, and interpretation.

Currently in the teacher's working sessions, each teacher shares her videotape; discussions merge the "reporting of" details with the anecdote telling and interpretation stages. Although the elements we included in our way of working are present in the sessions, they no longer exist as formal concrete steps. Instead, teachers discuss interpretations, backed by details from the tapes. They share instances where they see their students behaving in similar or different fashions when appropriate. Teachers move seamlessly among the stages in the process, in an cyclical, iterative manner rather than the formal linear sequence we outlined. The teacher educator has to do much less questioning and leading of the discussion than initially. This way of analyzing and discussing video anecdotes has become a natural way to view videotapes.

Comparing expectations with videotaped events is useful for reflection.

The use of anecdotes, in our case as videotaped examples of incidents from practice, can be enhanced through the active process of recording expectations prior to teaching a lesson, teaching the lesson, and reflecting back on the lesson in light of expectations for the lesson. Currently, teachers videotape their students solving a mathematical problem and vocalizing what they are doing and why. Before they tape the sessions, they list their expectations for the children in their journals. As they view their videotapes, they reflect on what happened. The teachers share these videotapes in their working sessions with the group. We have found that the tapes and journals provide a very effective means of assessing what the teachers are thinking about teaching and learning mathematics in their classroom. In addition, the theoretical framework we developed from our analysis of classroom videotapes is useful means of categorizing teachers' thinking.

Teachers are reluctant to conduct similar discussions on-line

Currently, the teacher working sessions are devoted to examining what children are thinking. However, between teacher working sessions, the teacher educator posts action items to a web site and teachers are expected to work on problematic issues that arise in conducting active productive classroom discussions on-line. They are asked to a)record their expectations for their class discussion, b) conduct and videotape their class discussions, c) compare their expectations for the class discussion with what they observed on the videotape, and d) discuss their expectations and what happened with the other teachers in the group though e-mail and listserves. However, for one reason or another, the teachers have not participated in these discussions on-line.

Conclusions

The purpose of this presentation was to outline a "way of working" with anecdotes that channels our natural tendencies to share our stories with colleagues into a strategy for the continued development of practicing professionals. Think back to the last time you sat around a teachers' lounge or met with a group of professionals who work primarily in isolation. Sooner or later, they began telling anecdotes about the workplace. One anecdote leads to another. Participants share stories and develop a sense of community, a sense that they are not alone in their frustrations and joys. But conversations of this nature seldom go beyond developing a sense of shared experiences. Although we investigated our way of working with elementary school teachers of mathematics, this model of professional development can be applied in a variety of contexts where the goal is to empower professionals to develop and improve their own practice.

This approach offers teachers a way of working first as a group with a teacher educator, and later individually as they examine their own classroom context for learning. We have provided support materials and developed a professional development model that encourages teachers to use video vignettes to focus on issues that arise in their classrooms. In this regard, an attempt is made to link the work done as a group to practice in classrooms using video as a tool the bridge the traditional gap between teacher education and classroom practice. The video anecdotes serve as a shared experience to generate discussion of issues in their own classrooms. By working though the steps in the process, the group receives support as they extend the ideas that emerge through the group discussion to practice in their classrooms. Members of the group work together collectively to identify issues, share experiences, and learn more about creating contexts in classrooms for learning mathematics with understanding.

Currently, the project team is analyzing videotapes and journals from the teacher's working group to determine how teachers create and modify their knowledge through participating in this type of professional development program and exploring ways to extend this methodology to distributed learning environments. Although we have began to explore the use of anecdotes for the professional development of elementary mathematics teachers, this approach to professional development is a logical extension of the case method with applicability to the professional development of any practicing professional; I encourage others to explore the use of anecdotes in other contexts and with different groups.

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Web-Based Distance Instruction: Design and Implications of a Cybercourse Model

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Abstract

The Web has drawn more and more distance educators' attention and been employed extensively as a distance learning delivery tool. The key concept of Web-based distance education focuses on applying the Web as a bridge to provide instructional communications and activities between students and teachers. However, without pedagogical considerations and effective distance learning activities, Web-based distance learning could be inactive and dangerous. Therefore, a cybercourse model is designed and created by infusing four beneficial telecomputing activities into Web-based distance learning system. Differences between the regular system and innovative model are compared and contrasted. The advantages and limits of the model are discussed. Finally, implications and conclusions are provided.

Introduction

The World Wide Web (WWW) holds a great potential for distance education. The most prominent characteristics of employing the Web as a distance learning tool is that it becomes available not only in classrooms, but dormitory rooms, public library, and indeed, anywhere in the world. As more and more distance learning activities occur on the Web, a comprehensive web-based model with effective pedagogical considerations is relatively crucial for distance educators.

In distance education, there is a high need to vary both the curriculum materials and instructional activities to engage students in learning. With the Web, instructors could design and develop interactive curriculum materials, build interactive pedagogical animation and sounds to motivate students' learning, and utilize a variety of web-based distance educational activities such as collaborative learning, demonstrations, interactive discussion, and problem solving.

The model presented in this paper is not for distance educators to follow instead it aims to provide a distance activity structure for them to contemplate, to apply, and then to be able to design and develop their own distance learning course which could best meet their specific instructional needs. In this paper, basic Web-based distance learning concept is first synthesized and systematized. Then, a cybercourse model is presented by weaving four beneficial telecomputing activities into Web-based distance instruction. A comparison between the regular system and new model is followed. Discussions on the strengths and weaknesses of the model are made. Finally, implications and conclusions are included.

Web-based Distance Education System

Utilizing the Web as an instructional delivery system is the basic concept of Web-based distance education. Applying WWW as a demonstration tool is the key instructional activity held by Web-based distance educators. Instructors post course syllabus, curriculum materials, and resources guidance on the Web to allow students to read, learn, and conducting electronic field trips.

In a Web-based distance instructional system, teachers should prepare, post, and update their course syllabus, curriculum materials on the Web regularly. In the course syllabus, teachers should clearly and specifically addressed what type of hardware and software configuration is needed for the course; what instructional activities will be conducted and how to perform those activities during the semester; and when the specific learning activities will be conducted. How summative and formative evaluation will be permeated into the whole learning process also have to be considered.

On the other hand, students are required to access the Web to review course materials, perform learning activities and publish their course products on the Web. In the Web-based distance learning system, the Web performs as a bridge to serve the teaching and learning activities occurring between teachers and students. Based on the notion, a regular Web-based distance learning is systematized (See Figure 1).

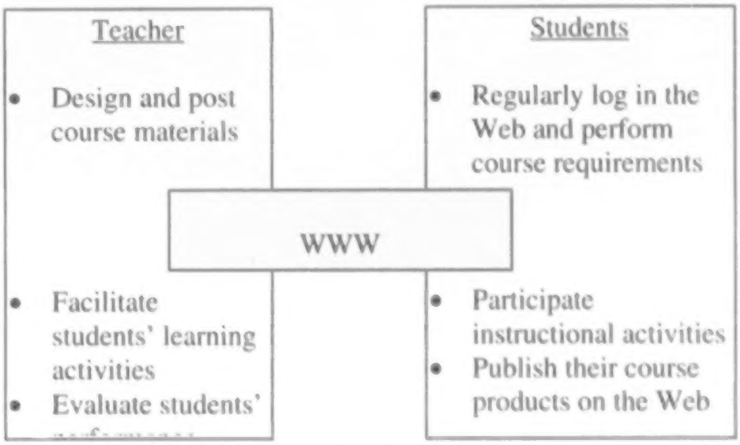
Teacher
Design and post course materials
Facilitate students' learning activities
Evaluate students'
WWW
Students
Regularly log in the Web and perform course requirements
Participate instructional activities
Publish their course products on the Web

Figure 1: A Regular Web-based Distance Education System

A Cybercourse Model

Based on the above-mentioned distance instructional system, a Web-based cybercourse model is designed and formed by infusion four beneficial distance educational telecomputing activities into such system. The four beneficial distance learning activities are collaborative learning, demonstration, interactive discussion, and problem solving. Following are specific discussions on how to apply these four major beneficial learning activities in the Web-based distance learning system.

Collaborative Learning

Literature review suggests that collaborative learning is a type of instruction that could meet the needs of students of any styles (Ellsworth, 1994). Collaborative learning is supported by the use of research-based projects via the Web. Instructors could assign students into either large or small groups to conduct electronic researching on course related topics.

Demonstration

Instructors could apply WWW as a demonstration tool for instruction. Instructors post course syllabus, curriculum materials, or students' products for learners to read, discuss, and evaluate. In addition, instructors could provide guidance about the content-related educational resources and allow students to conduct an electronic field trip in viewing those resources.

Interactive On-line Discussion

Interactive Web-based discussion provides on-going information sharing, facilitates active learning, and can be controlled by the teachers. The Web with its great capability offers various methods for encouraging on-line conversations between teachers and students. The electronic conversation between teachers and students could be made through Email, Listserv, newsgroups, Web conference page, and synchronous discussion (chatting). Email is the most simple, direct, and effective instructional strategy in a Web-based distance cybercourse. It can become the principal tool for maintaining interactions between students and teachers.

Listserv are automatic mailing lists. In the cybercourse model, instructors could create a listserv for their specific class discussion. Through the listserv, instructional materials and messages could be mailed mandatory and automatically to all of the students' email addresses subscribing to the listserv.

In addition, interactive electronic conversation could be implemented by creating a private discussion newsgroup to allow students conduct on-line discussion and post their opinions and responses. Newsgroups could also be used to broadcast and post information to students about courses, schedules, events, speakers, and so on.

Web conference pages offer another alternative for interactive on-line discussion. Web conference indicates creating a Web site that allows learners to submit their discussion contents and opinions in a designated Web page so that each student in the class is able to read their peer's comments and ideas and respond his/her own discussion contents simultaneously or asynchronously.

Different from Email, synchronous discussion (chatting) allows both teachers and students connect and discuss at the same time. Such discussion provides a great group opportunity for distance learning via the Web.

Problem Solving

Problem solving activities are one of the most beneficial educational activities for students of any age (Ellsworth 1994). Such activities could be integrated by Usenet and extensive use of the search tools, online gathering from rich educational Web sites, and electronic information exchange tools.

Accordingly, with interweaving the four distance learning activities into the regular Web-based distance education system, a cybercourse model is created. Figure Two shows the innovative model of Web-based cybercourse.

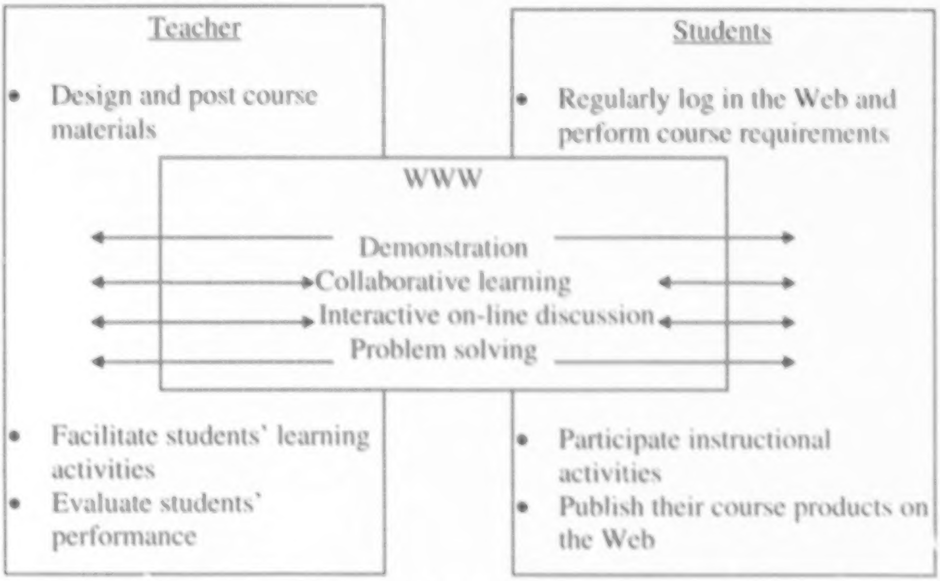
Teacher
• Design and post course materials
Students
• Regularly log in the Web and perform course requirements
WWW
Demonstration
Collaborative learning
Interactive on-line discussion
Problem solving
• Facilitate students' learning activities
• Evaluate students' performance
• Participate instructional activities
• Publish their course products on the Web

Figure 2: The Cybercourse Model

Comparison

The significant difference between the regular Web-based distance learning system and the innovative cybercourse model is the four instructional telecomputing activities. The four activities not only activate the entire cyber learning but also help instructors contemplate about their teaching. Therefore, two contrast perspectives are pointed out and discussed in the following:

Active Learning Versus Passive Learning

The Web could be a very passive tool if students just browse the posted materials and randomly clicking without any thoughtful or interactive activities. If an instructor skillfully weaves the four telecomputing activities into his/her Web-based distance instruction, students' learning will be totally different. Collaborative learning allows students to have interaction with their classmates and engaged in the learning process. Electronic conversation provides excellent opportunities to stimulate computer-mediated communication between teachers and students. Problem solving activity facilitates students' synthesizing and organizing skills.

Mindful Teaching Versus Thoughtless Teaching

It is always easy for an instructor to follow and perform the instructional agenda listed in the regular Web-based distance learning system. However, to integrate the four instructional telecomputing activities requires extensive and deep thinking. Several questions have to be considered. For example, how is the collaborative learning going to occur between the remote students via the Web? What types of problem-solving activities are able to meet the curriculum purposes?

Discussions

Good application of the Web-based cybercourse model could promote not only active teaching but also effective learning. To ensure a practical utilization of the model in distance education, instructors should realize its advantages, limits, and implications.

Advantages

Web-based distance learning provides three advantages over other distance educational technology systems. The three benefits are: no time and space limit, synchronous and asynchronous communication, and linear and nonlinear learning. Specific discussions about the three advantages are as follows:

No Time and Space Limit

Through the cybercourse, learning can be taken place at any convenient time and anywhere in the world. Teachers can contact with any one of their students or students can contact any one of other students taking the same course early in the day, after midnight, while traveling, at conference, at home or at the office, without being tied to fixed schedules.

Synchronous and Asynchronous Communication

Communication between teachers and students could occur at the same time or at different time in such a Web-based distance course. The great power of the Web-based instruction is that both instructors and students could express their thoughts and opinions at any time and at any location.

Linear and Nonlinear Learning

Learning via the Web allows students to proceed self-paced learning. Students can have great latitude in directing their own learning in a manner compatible with their learning styles.

Disadvantages

Because of the Web's advantages of allowing access at any time and any place, there are two corresponding disadvantages. They are the difficulty of document students' performance and difficulty in tracking students' exploration on the Web. Following is the specific discussions.

Difficult of Documenting Students' Performance

So far, it is still very difficulty to document students' efforts or performance on the Web. Although most of the hypermedia programs such as HyperCard are able to get an indication of time on task for students using the instructional software. There is no easy way to record students' time on task while they use the WWW.

Difficult in Tracking Students' Access

It is also difficult to track whether students have been to a Web site that could mark as an effective choice for great learning. "The Web's greatest intrinsic power is that it encourages branched and nonlinear instruction (Brooks, 1997. P. 28)." Students can not only jump around the materials that the instructors have created for them, but also can access information created by other.

Considerations

When applying the Web as a distance learning medium, instructors have to take into considered the following three points. First, are electronic conversations less effective than face-to-face conversation? While electronic conversations are the major channel to communicate between teachers and students, its instructional effect become an essential issue. The importance of face-to-face instruction has been emphasized in the distance learning fields (Brooks, 1997). Thus, an instructor might consider offering one or two sessions for meeting with their students at remote sites.

Second, does Web-based distance learning provide less favorable learning for a field dependent person? Research studies indicated that students' learning style did make a difference in their learning (Witkin et al, 1967;

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Greenbowe, 1996). While Web-based distance learning is mainly delivered via electronic conversation, will field dependent learners perform poorer than the field independent learners just because such course offer less scenic interaction between teachers and students than the traditional teaching? Witkin (1949) also found that there was a significant sex difference in field-dependent/independent performances. Females tend to be more field-dependent. Accordingly, an interesting research question was generated: Will male students perform better than female students in a Web-based distance learning course?

A final consideration regards to the issue of "Web-based misinformation (Brooks, 1997. P. 28)." We all know that the WWW contains huge information and resources. The quality of the information resided in the Web varies a lot. Some are with professional knowledge; some are not. Students are quite possible to access misinformation on the Internet. To avoid our students wasting too much time in assimilating the misinformation has been an enormous challenge for distance learning educators.

Implications and Conclusions

The Web-based cybercourse model implies not only the applicability of distance learning but also the expansion in infusing technology into the entire educational setting. Undoubtedly, Web-based distance learning could be applied to all levels of education because its rich resources containing knowledge in all levels. Further research studies regarding the instructional effects of Web-based distance learning will be and should be investigated. No matter what research results will be generated, the Web will definitely continue to encourage educators to integrate it in their teaching and learning process.

In sum, there is no question that Web-based distance course with its unique advantages and beneficiary learning activities will attract more and more educators to adopt such instructional strategy. Indeed, the Web with its flexible and universal capabilities is just the right tool to design and develop an effective and versatile distance educational course.

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Optimal Shifting of Fidelity Levels in Computer-Based Instructional Simulation

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Abstract

The purpose of the study seeks ways of developing and utilizing more efficient Computer-Based Instructional Simulations (CBIS) based on the relationship among fidelity levels ("how closely a simulation imitates reality"), transfer of learning, and learning time. The hypotheses presented in this study suggest how to determine the optimal shifting points of the fidelity levels; this method yields the optimal routes that would help learners reach the goals with less time in CBIS. To verify the hypotheses, 148 seventh grade male students were selected voluntarily from one junior high school in Korea, and a 4 X 6 (Fidelity Levels X Number of Lessons) posttest-only experimental design was employed. Even though the result failed to support main hypotheses due to no distinct difference among fidelity levels of CBIS, the result shows that a cost-effective point on learning time exists in a given level of fidelity of CBIS. Therefore, the hypotheses need to be tested again in further well-designed experiments with a larger range of fidelity.

Theoretical Background

Fidelity means "how closely a simulation imitates reality" (Alessi & Trollip, 1991). The relationship between the levels of fidelity and transfer of learning has been an important issue in the field of training simulators because the levels of fidelity are deeply related with the cost of the simulator (Miller, 1974; Buam *et al.*, 1982; Su, 1984). In addition, controlling the levels of fidelity has been considered to achieve cost effective transfer of learning (Hays & Singer, 1989). Though the flexibility of switching fidelity levels in Computer-Based Instructional Simulation (CBIS) enhances the importance of controlling fidelity levels and its benefits, there are few case studies. Thus, this study focuses on how to determine the optimal shifting points of the fidelity levels on the basis of the relationship between the amount of the learning time and transfer of learning in Computer-Based Instructional Simulation (CBIS).

Case studies on the relationship between fidelity and transfer of learning have yielded different results. One viewpoint is that the higher fidelity of simulation, the better effect of learning (Ornstein, *et al.*, 1954; Dougherty, *et al.*, 1957, Allen, Hays, & Buffardi, 1986). These study results are based on the traditional theory of identical elements (Thorndike, 1913-1914; Yum, 1931; Gibson, 1939; Osgood, 1949). On the other hand, a second point of view maintains that better transfer of learning may be attained through lower levels of a simulation fidelity for students in their early stages (Valverde, 1973; Boreham, 1985), because the higher fidelity of simulation may raise the complexity of instructions, which decreases the effect of learning (Alessi, 1988).

The synthesized assumption was presented by Miller (1974), Alessi (1988), and Hays and Singer (1989). They suggested that the levels of fidelity are decided according to the "stages of learning," that is, "the student's current instructional levels," and the most cost effective simulation learning is that the higher levels of fidelity replace the lower levels as the instructional levels of students improve. In addition, Roscoe (1971) and Povenmire and Roscoe (1973) have shown that the cost effectiveness of learning in the certain level of fidelity is inversely proportional to the amount of learning time.

Research Questions

This study supposes that each level of fidelity would draw a different increasing curve of transfer of learning according to the learning time (Hypothesis I) as presented Figure 1. If the assumption of Figure 1 is true, the optimal shifting time from Fn-1 to Fn, or from Fn to Fn+1, would be determined at the point where the gap of transfer of learning between the consecutive two levels of fidelity (Fn-1 and Fn, or Fn and Fn+1) is maximum (Hypothesis II, Figure 2). Therefore, the suitable shifts of the fidelity levels according to the learning time would have learners reach the goal with less time in CBIS.

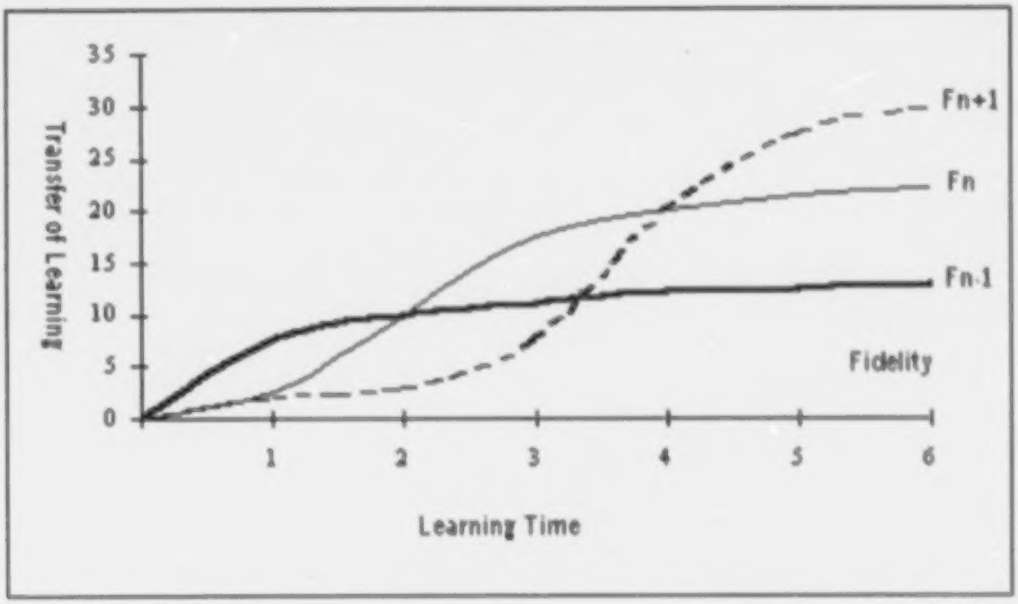

Figure 1. Relationship between transfer of learning and learning time according to fidelity levels (Hypothesis I)
Note: Fn: Given level of fidelity. Fn-1: Lower fidelity than Fn. Fn+1: Higher fidelity than Fn.

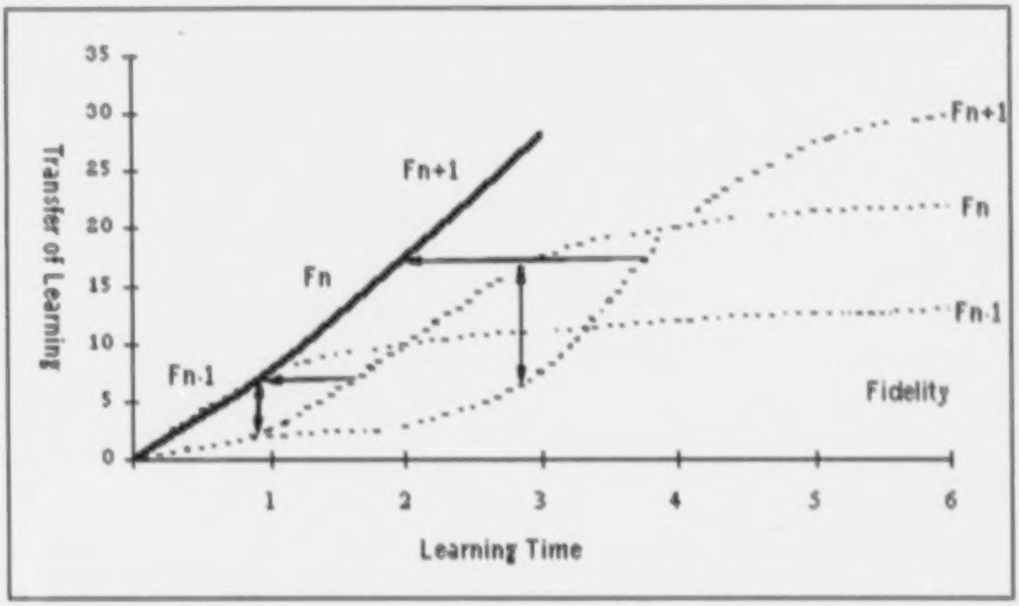

Figure 2. Optimal shifting of fidelity levels and its benefit (Hypothesis II)
Note: Fn: Given level of fidelity. Fn-1: Lower fidelity than Fn. Fn+1: Higher fidelity than Fn.

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Research Method

Sampling and Experimental Design

To verify the above hypothesis I presented in Figure 1, 148 seventh grade male students were selected voluntarily from one junior high school in Korea. They had already taken the same classes about the basic use of the Windows 3.1 system in IBM compatible computers. For the experiment, a 4 X 6 (Fidelity Levels X Number of Lessons) posttest-only design was employed.

Operational Definitions

In this experiment, fidelity level means the number and flexibility of actions that the student may take in operating simulation. The learning time is the number of simulation lessons that the student took. Transfer of learning refers to the amount of profit generated by the student through the manipulation and utilization of several variables during the posttest business simulation.

Material

The content of instruction was limited to basic knowledge and common sense in economics, which is treated as a social science subject in the fifth and eighth grades. The students ran the simple fruit store in CBIS. A CBIS program with four different levels of fidelity was developed. Table 1 shows the standards used for classifying the different levels of fidelity in the CBIS development process.

Table 1. The standards for classifying the levels of fidelity

	The factors of classifying	The levels of fidelity				
		1	2	3	4	E*
Number of action	Determination of fruit order quantities	Yes	Yes	Yes	Yes	Yes
	Determination of fruit sale prices	No	Yes	Yes	Yes	Yes
	Selection of fruit types	No	No	Yes	Yes	Yes
Flexibility of action	Number of fruit types to sale/ Total number of fruit types to select	NA	NA	1/2	2/3	2/3

Note: *E means the fidelity level of posttest simulation.

Procedure

The students were randomly assigned to the four groups of differing levels of fidelity, and they practiced the CBIS set at their group's level of fidelity for two minutes. Immediately thereafter, they were evaluated for two minutes by the posttest simulation, which was the highest level of fidelity. In this manner, two minutes practice and two minutes test were repeated six times to estimate the curve of transfer of learning. The responses of the students, the net profits during the test simulation, were recorded in the computer.

Results

[1] As presented Figure 3, there were no differences among the four increasing curves of transfer of learning which each level of fidelity drew through the learning time. [2] Meanwhile, the transfer of learning for the CBIS varied with the six gradual stages of learning time, F (5, 739)=36.3, p<.001. The post-hoc analyses indicated that the transfer of learning curve marked a sharp rise at the first and second simulation lessons (learning time) with statistical significance, and then it flattened out after the second lesson (Figure 3).

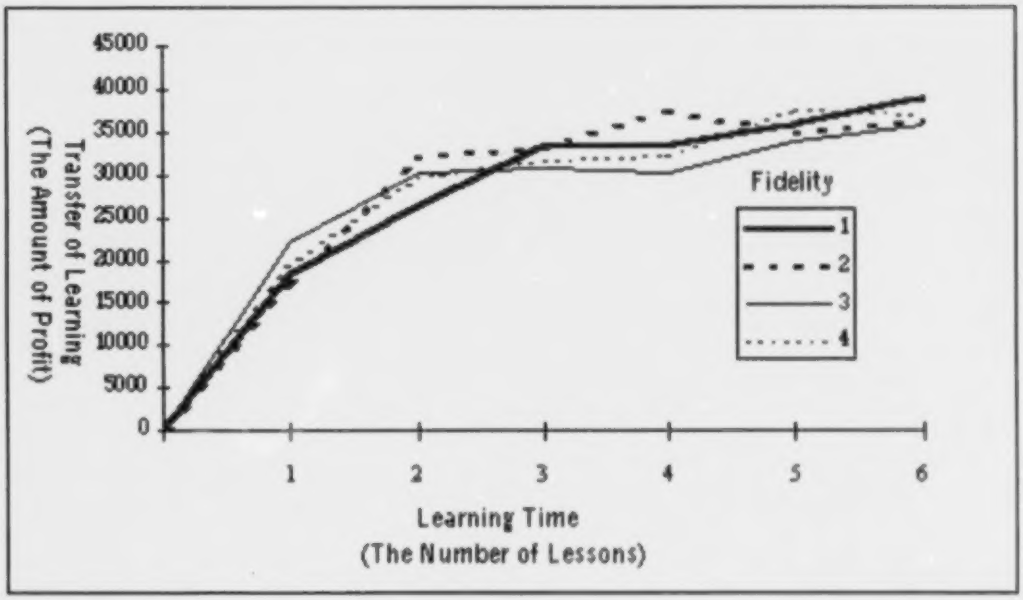

Figure 3. Relationship between transfer of learning and learning time according to fidelity levels (Result)

Discussion & Implication

The result [2] supported by Roscoe(1971) and Povenmire and Roscoe(1973) implies that CBIS has the cost-effective point on the amount of learning time. In this case, it is most cost-effective to stop instruction after the second simulation lesson.

The result [1] has two possible interpretations. First, the lack of an effect by the levels of fidelity on the transfer of learning in this experiment may be attributable to the lack of any real differences in the levels of fidelity of the CBIS developed. Actually, this assumption (Figure 1) is based on Alessi's comprehensive model (1988); the fidelity levels should be determined by a variety of aspects-underlying models, presentations, user actions, and system feedback- and a wide range of situations-form the low level fidelity to the actual experience. In this experiment, however, the four different levels of fidelity considered only the user action aspect, and the close intervals of fidelity levels were all admittedly in a low range due to limited financial resources. Therefore, the assumptions (Figure 1 and 2) will be tested again in further well-designed researches with a larger range of fidelity.

The second interpretation is that the levels of fidelity may be not important variables on transfer effects in CBIS. The researches and claims of Cox, *et al.* (1965), Grimsley (1969), Hopkins (1975), and Johnson (1981) in the field of simulators may be regarded as being consistent with the results of this study. In addition, psychological aspects of fidelity may be more important than the physical aspects of it (Prather, 1973; Dittrich, 1977). Finally, psychological aspects of fidelity in CBIS will have to be considered in further researches.

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Computer Conferencing and Multiple Intelligences: Effects on Expository Writing

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Abstract

The purpose of this study was to examine the differential effects of computer conferencing on expository writing for students (n = 109) of seven intelligence types. Students were assigned to four treatment groups that provided controlled exposure to a writing-prompt: unstructured exposure, computer conferencing, face-to-face discussion, and computer conferencing combined with face-to-face discussion. Following treatment all students wrote an essay on the writing-prompt. MANOVA indicated that participation in computer conferences did not significantly improve scores on essays. However some interactions between treatments and intelligence type were significant. Results indicate that intelligence type is an important instructional variable when implementing computer conferences.

Background

The application of computer conferencing as a teaching/learning tool is increasing dramatically as more educational institutions gain access to the Internet. Several researchers have found that computer conferencing (CC) can be a powerful force for facilitating discussion and for encouraging writing (Kiesler, Siegel, & McGuire, 1984; Rafaeli & Sudweeks, 1996; Tagg & Dickinson, 1995). Research on computer conferencing has been based largely on analysis of conference transcripts and results of attitude surveys. For instance, in one study discourse analysis revealed that CC contributed to preservice teaching apprenticeship and learning of educational psychology by providing for positive communication during early field experiences: "students were heavily involved in electronic learning....and teachers electronically scaffolded or apprenticed learning ...without giving away answers" (Bonk, Malikowski, Angeli, & East, 1997). There has been, however, little investigation of external outcomes of computer conferencing. In this study we investigated the effects of CC on expository writing beyond the CC.

The researchers' assumptions about the postitive effects of CC on learning as reflected in expository writing were based upon constructivist learning theory which indicates that providing learners with opportunities for written reflection, interaction, shared perspectives, and mentorship each contribute positively to knowledge construction (Driscoll, 1994). In CC participants grapple with their ideas and think through their entries before carefully constructing messages and replies to others' messages. They read each others' ideas and responses to their entries. On-line dialog that results provides students with the opportunity to test and refine their understandings in an ongoing process.

Multiple Intelligences

In addition to investigating the comparative effects of face-to-face (f-f) discussion, CC, and a combination of CC and f-f discussion, we included a second facet to our study: investigation of the interactive effects of CC and multiple intelligences on student learning. In a similar study, Brenner and Hill (1997) explored the comparative effects of asynchronous distance learning on acheivement for field dependent versus field independent learners and found no interaction. However, the theory of multiple intelligences indicates that students' individual intelligence types must be addressed through varied strategies (Gardner, 1993). Therefore, multiple intelligences have become important variables to instructional designers and have implications for the use of CC for learning. The seven intelligences identified by Gardner are-- linguistic, logical/mathematical, spatial, bodily/kinesthetic, musical, interpersonal, and intrapersonal. Interactions between type of intelligence and instructional media applications need to be identified so that alternative teaching strategies can be applied to learners according to their type(s) of intelligence. Because CC provides for linguistic, interpersonal learning we expected learners of different intelligences to be differentially effected by CC.

Research Questions

In this study researchers investigated the effects of CC on student expository writing. We asked whether or not students learned from their on-line discussions, above and beyond f-f discussions. Specifically-- 1) did students who participated in a computer conference on a particular topic write better essays on that topic than students who did not participate in a computer conference on that topic, and 2) did students who participated in the combination of a f-f discussion and a computer conference on a particular topic write better essays on that topic than students who did not participate in a computer conference and f-f discussion on that topic? In addition we asked, 3) did computer conferences differentially affect writing for students of different intelligence types. We also attempted to identify process variables that contributed to effective on-line and f-f discussions.

Based upon constructivist theory we expected CCs and f-f discussion to positively affect writing above and beyond the effects of unstructured study or f-f discussion alone. In addition, multiple intelligence theory connoted that unstructured study time, CC, and f-f discussion would have differential effects on learning as reflected in expository writing. Specifically, we expected that students with linguistic, logico-mathematical, spatial, and interpersonal intelligence types would be positively effected by CC while students with musical, bodily-kinesthetic, and intrapersonal intelligence types would be unaffected or negatively affected by CC. We made these hypotheses because CC is a print-based, linguistic, writing activity that involves collaborative construction of meaning.

Methods

Ninety-nine undergraduate students enrolled in an introductory educational technology course in spring 1997 at Texas A&M University were divided into four, 11 day CCs in which they discussed different topics on educational technology. They used FirstClass™ software to conduct CCs which were moderated by the instructor who also led classes in their f-f discussions of the topics.

The moderator's role in both CCs and F-F discussions was to provide structure, keep students on topic, and weave threads of the discussion (Berge, 1995; Eastmond, 1992).The CC structure was such that the instructor entered the questions in FirstClass for the writing-prompt for the CC group and CC/F-F groups. With the exception of brief comments from the moderator and weaving in each of the groups, students had free reign to discuss what ever topics emerged. The moderator attempted to control for extended tangential discussions by creating new folders for those discussions.

The CCs in this study involved reading a discussion topic that was entered by the instructor, entering a response to that topic in the CC, reading other's responses, and replying to those responses. In contrast to experiences in face-to-face (f-f), participants had opportunities to reflect upon their ideas. As a result, responses were likely to be less spontaneous and more deliberate than in f-f discussion. They were also likely to demonstrate deeper understanding and be more clearly stated.

Study Design

In this study we used quantitative and qualitative methods to answer the research questions. A "Posttest-Only Control Group Design" with four treatment groups was used to explore the comparative effectiveness of unstructured study time (control group), f-f discussion only, CC discussion only, and both f-f and CC discussion. Participants were not randomly assigned to groups. Instead they received treatment within their lab sections. The writing-prompt discussion topic was-- What impact might the combination of instructional design, media, and computing have on learning? A placebo discussion topic was used in CCs and f-f discussions for treatments that did not include CC or f-f discussion of the writing-prompt. The placebo writing-prompt was-- What classroom management strategies might you use for integrating technology in the curriculum?

Students were assigned to four treatment groups:

1) Control Received no exposure to the writing-prompt discussion topic via CC or f-f discussion. However, they did receive exposure to the writing-prompt discussion topic through readings, lecture, assignments, and unstructured study time.

2) F-F Participated in a 20 minute f-f discussion on the writing-prompt discussion topic and received exposure to the writing-prompt discussion topic through readings, lecture, and assignments.

3) CC Participated in a discussion of the writing-prompt in a moderated 11 day computer conference and received exposure to the writing-prompt discussion topic through readings, lecture, and assignments.

4) F-F/CC Participated in a discussion of the writing-prompt topic in a moderated 11 day computer conference, participated in a 20 minute class discussion on the writing-prompt discussion topic, and received exposure to the discussion topic through readings, lecture, and assignments.

Data Sources

The data sources included contents of CCs, the essay scores, and multiple intelligences inventories. Average number of entries and sittings to make entries were determined for each treatment group. Scores on essays written about the writing-prompt following treatment were determined using the instrument, The Composition Profile (Hughey, J.B. & Wormuth, D.R. 1985, r=.98). The dependent variables were scores on the quality of the contents, organization, and overall composition of essays on the writing-prompt discussion topic. Students' essays were scored independently by three readers trained in the use of the instrument. Face, content, and construct validity have been established for the instrument.

We established rater reliability for the essays by having two readers assess each paper according to content, organization, and composition score (a composite of content and organization). We assessed the reliability using Pearson Product Moment formula. Reader reliability was .92 for content, .78 for organization, and .91 for composition with a 7% discrepency rate.

The self-report Multiple Intelligences Inventory (MII) was administered and participants' types of intelligences were identified through scoring this instrument (Armstrong, 1993). Students were classified as having one of the seven intelligences if they selected six or more of the ten possible behaviors used to describe each intelligence.

Results

The CCs contained 344 messages from participants and 24 moderator messages. Participants and moderators differed in their degree of participation in the CC across groups. The group that computer conferenced without a f-f discussion on the writing prompt participated slightly more than the other groups. The moderator appears to have been most active in the CC & F-F group making nine entries in eight sittings (see Table 1).

Table 1. Activity in Computer Conferences by Groups

Participants	N	# of entries/ ave. # per person	# of sittings/ ave. per person	Mod. entries	Mod. sittings	Nonparticipation in CC
Control	17	66/4	54/3	3	3	1
F-F	28	75/3	63/2	6	6	1
CC	28	115/4	93/3	6	6	0
CC & F-F	26	88/3	65/4	9	8	2

Although participants were not assigned to groups according to their types of intelligence, the types dispersed across groups fairly evenly. However, the control group is the only group with strength in linguistic intelligence and they are stronger overall in the intelligences. Table 2 shows that the control group had linguistic, spatial, bodily-kinesthitic, musical, and interpersonal intelligences. The other three treatment groups had bodily-kinesthitic, musical, and interpersonal intelligences.

Table 2. Mean Scores on Multiple Intelligence Inventory by Groups

MI	Control		F-F		CC		CC&F-F	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
L	5.8	2.2	4.1	1.9	4.5	2.4	4.7	2.2
LM	3.9	2.6	4.4	2.8	4.1	3.2	4.2	2.0
S	5.5	2.5	4.6	2.2	5.4	2.1	4.5	1.8
BK	5.6	2.9	5.8	1.9	5.9	2.2	5.7	2.4
M	6.7	2.9	5.5	2.8	7.0	2.4	6.0	2.4
TER	6.1	2.6	5.6	2.4	6.1	2.3	5.5	2.4
TRA	4.9	2.2	3.9	1.5	4.5	2.0	4.6	2.0
Total	38.5		33.9		37.5		35.2	

A MANOVA was used to determine if differences between treatment groups existed and if the treatments interacted with intelligence types. Follow-up correlations indicated how treatments interacted with intelligence types. The independent variables of treatment group and intelligence type were tested across the three dependent variables: content of essay, organization of essay, and overall composition of essay. Treatment groups did not differ significantly on expository writing. Students who discussed the writing-prompt in their CC and/or f-f discussion did not perform significantly better on the three measures than those who did not discuss the writing-prompt in a CC and/or f-f discussion (see Table 3).

Table 3. Scores on Content, Organization, and Composition by Groups

GR	N	Mean Content	SD Content	Mean Organization	SD Organization	Mean Comp.	SD Comp.
Control	17	21.32	4.03	14.85	2.78	36.18	6.55
F-F	28	20.08	3.93	13.67	2.42	33.78	6.11
CC	28	21.75	3.70	14.93	1.95	36.68	5.15
CC&F-F	26	22.71	3.92	15.17	2.55	37.88	6.18

Computer conferences and f-f discussions differentially affected learning for students with different intelligence types. Students with interpersonal intelligence who participated in f-f discussions but did not computer conference on the writing-prompt benefited from such treatment. They out performed other students in writing content, organization, and overall composition. Students with intrapersonal intelligence were negatively affected by CC and f-f discussion on both writing content and overall composition. However, CC alone and f-f alone did not negatively affect intrapersonal intelligence types' writing. Students with bodily-kinesthetic intelligence were negatively affected on overall composition by CC without f-f discussion (see Table 4).

Given the control group's linguistic and spatial intelligence we would expect them to perform well on an essay. Differences between groups' intelligences may provide an explanation for the lack of difference between the control group and the other groups, particularly the CC & f-f group. Much to our surprise, students with linguistic intelligence appear to be unaffected by the treatment. We can hypothesize that the control group did well on their content, organization and overall composition because of their strong multiple intelligence and because they were less needy of CC and f-f discussion to support their learning of the writing prompt during unstructured study time.

Table 4. Multivariate Analysis of Variance of Scores on Content, Organization, and Overall Composition by Multiple Intellegence

Source	Variable	SS	df	MS	F	Sig.
Group(GP)	Content	96.00	3	32.00	2.12	.102
	Organization	36.35	3	12.11	2.10	.105
	Composition	244.54	3	81.51	2.29	.082
GP*L	Content	26.20	4	6.55	.52	.716
	Organization	32.22	4	8.05	1.62	.177
	Compostition	83.53	4	20.88	.727	.577
GP*LM	Content	54.55	4	13.63	1.09	.365
	Organization	17.05	4	4.26	.86	.492
	Compostition	118.7	4	29.6	1.03	.396
GP*S	Content	88.02	4	22.00	1.77	.144
	Organization	15.01	4	3.75	.758	.556
	Compostition	170.91	4	42.73	1.48	.216
GP*BK	Content	123.23	4	30.80	2.48	.052
	Organization	45.45	4	11.36	2.29	.068
	Compostition	308.17	4	77.04	2.68	.039*
GP*M	Content	92.01	4	23.00	1.85	.129
	Organization	34.92	4	8.73	1.76	.146
	Compostition	223.99	4	55.99	1.94	.112
GP*TER	Content	126.93	4	31.73	2.55	.046*
	Organization	61.61	4	15.40	3.10	.021*
	Compostition	351.82	4	87.95	3.06	.022*
GP*TRA	Content	144.31	4	36.07	2.90	.028*
	Organization	44.35	4	11.08	2.23	.074
	Compostition	333.63	4	83.40	2.90	.028*

*$p > .05$

L=Linguistic, LM=Logical/Mathematical, S=Spatial, BK=Bodily Kinesthetic, M=Musical, TER=Interpersonal, TRA=Intrapersonal

Another possible explanation for the lack of effects of CC is that the writing prompt may have been too easy for participants to address during unstructured study of the text and lecture notes. A follow-up study using a writing prompt on a topic that no participants have had exposure to might provide better understanding of the effects of CC on writing.

Educational Significance and Implications

Evidence from this study indicates that CCs do not affect expository writing about a specific writing prompt above and beyond f-f discussions or unstructured study. While the writing prompt did not appear to be learned through CC and/or f-f discussion, except for for interpersonal learners, we still value CC as a facilitator of collaborative learning. Students used the medium to address topics of interest to them and collaboratively constructed meaning about topics of their choice. We had a specific objective in mind for learning in the CC. Students took tangents from this objective as they discussed content of special interest to them. Collaborative, social learning environments such as CC may not provide an atmosphere for learning specific objectives.

Therefore, a follow-up study involving content analysis would be appropriate for identifying what was learned in these CCs. In addition, findings indicate that computer conferences might negatively affect writing about a specific writing prompt for students with different types of intelligence. Specifically, CC may interfere with bodily-kinesthetic and intrapersonal learners' abilities to write about a specified topic. Alternative media should be considered. These findings call for future investigation into specific facilitative strategies that might be employed within CCs in order to attain specific objectives and reach different types of learners.

This study expands the research base related to the impact of CC on student performance. We determined that intelligence types and CC interact to create a differential effect. Such findings speak to instructional designers regarding strategies for individualized instruction.

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Cultural Connections: Promoting Self-Esteem, Achievement, and Multicultural Understanding Through Distance Learning

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Abstract

This case study focuses on the effects of collaborative activities between two teachers and their students. We explored the effectiveness of distance learning for adolescents in promoting: 1) self-esteem, 2) achievement, and 3) multicultural understanding. In Cultural Connections, diverse students across Texas collaborated on multicultural activities which helped them grow in self-esteem, achievement, and multicultural understanding. This project demonstrates that in networked classrooms students can connect with distant others to learn about and from their perspectives and to increase their multicultural understandings. In addition, distance technologies can foster team teaching across cultures and geographical distances.

Background and Theoretical Perspective

In this case study, we explored the effectiveness of distance learning for adolescents in promoting: 1) self-esteem, 2) achievement, and 3) multicultural understanding. In our project, Cultural Connections, predominantly Hispanic students collaborated with diverse students in various schools via interactive videoconference, desktop videoconference, and computer conference.

The theory of transformative pedagogy suggests that the fundamental purpose of education is to promote personal growth in individuals. As individuals grow through education, they transform into responsible, caring citizens who affect society positively. To facilitate building a broad world-view in students, educators need to provide collaborative learning experiences for social construction of meaning. Telecommunications can be used to expand the range of exposure to multicultural interactions (Cummins & Sayers, 1995). In addition, multimedia technologies can be used for visual/verbal sharing of ideas across distances.

Distance technologies expand the range of opportunities for students to build relationships with people of different cultures. In the current social-constructivist conception of learning, "education is the shared way of thinking about one's self, the community, and the world" (Riel, 1995, p. 219). Schools might play a significant role in nurturing students' positive identity formation by providing them with opportunities to build distant relationships. In order to become more tolerant and respectful citizens, students need to develop relationships with people from diverse cultures and backgrounds (Moffett, 1994). Geographical and cultural isolation can limit opportunities for relationship building beyond one's culture. However, cross-classroom collaboratives allow students to connect with distant others from around the world. The collaborative learning process has the potential to transform individual participant's perspectives from parochial to global (Cummins & Sayers, 1995; Metcalf, 1994).

Cultural Connections is an open forum between distant classes that use telecommunications and multimedia technologies for collaborative learning. In collaboration with university researchers, 24 teachers from three schools developed several identity forming and multicultural curricular activities for their students to conduct over the distance. For instance, they developed multimedia activities from writing activities in *I Thought I Was from Another Planet* (Dresser, 1994), a book of short stories and writing activities designed to help students develop authentic writing voices and heighten their sensitivity to our multicultural world. Students did the activities, which involved writing and distance collaboration, and ultimately produced multimedia presentations of their work which they shared with their partners over the distance.

In another activity, students participated in a distance, open forum to discuss the pros and cons of school uniforms. Students conducted library and Internet research on the topic; they surveyed campus students and faculty; they calculated means; and they formulated, developed, and presented persuasive arguments across the distance.

In Cultural Connections, multimedia software and distance technologies were used to eliminate isolation. Student development of multimedia portfolios and cross-classroom collaboration were meant to foster the building of multicultural relationships while honoring the strength of diversity and emphasizing how similarities unify.

Research Questions

Participating teachers conducted at least nine distance learning experiences with their students over a school year. In this study we asked-- In what ways, if any, did the distance learning experiences affect 1) self-esteem, 2) school achievement, and/or 3) multicultural understanding in participating students?

Methods

Cultural Connections included Berta Cabaza Middle School in San Benito, Texas, which is located in the Lower Rio Grande Valley; Jones Intermediate School in Waller, Texas, which is located about 350 miles to the north of San Benito; and Somerville Junior High School in Central Texas. Participants in this study included 24 teachers and the 24 students of 2 of those teachers, 2 school counselors, 3 administrators, and 2 university faculty at Texas A&M University. Sixteen teachers at Berta Cabaza, six teachers at Jones Intermediate and two teachers at Somerville Junior High who teach math, science, language arts and social studies conducted Cultural Connections curricular activities. A counselor at Berta Cabaza partnered with a counselor at Somerville Junior High to conduct guidance activities. School principals and university faculty facilitated the project. All student populations in partcipating schools were racially and culturally diverse, and participating students equitably represented the ethnicity of the student populations of each school. The school and university partners were equipped with interactive compressed video systems, HyperStudio™ software, Internet connections, CU-SeeMe™ software, and FirstClass™ computer conferencing software.

This case study focuses on the effects of collaborative activities between two teachers and their students. The two teachers, one in San Benito and the other in Waller, partnered for planning and implementation of curricular activities with their students. They conducted the ongoing activities between October and June of 1996 and 1997. Fourteen randomly placed eighth grade students in San Benito and ten gifted and talented fifth-grade students in Waller were active in the project throughout the 1996-1997 academic year.

The investigation relied on ethnographic, case study methods. To determine effects of distance learning on self-esteem, achievement, and multicultural understanding, we conducted content analyses of each of the data sources. We looked for emergent themes and gained consensus on the extent to which the data sources revealed answers to the research questions. Data sources included participants' reflections, contents of videoconferences, students' HyperStudio portfolios, interviews of the students early in the school year and again at the end of the year, and evaluations of the Annual Distance Learning Videoconference attended by the 24 teachers.

In addition, to estimate the effects of Cultural Connections on achievement, we examined scores on three school benchmarking reading tests at Berta Cabaza in San Benito. The tests were administered to all students in the school as part of the school's accountability system. Only one class participated in Cultural Connections. We compared the scores of 14 students in the Cultural Connections, distance learning class with the scores of the students in the same teacher's classes that did not participate in Cultural Connections.

For purposes of this research we limited the definition of multicultural understanding to demonstrations of appreciation of others and breadth of world-view. To determine the degree of multicultural understanding, we analyzed contents of interviews and participating students' multimedia portfolios. The portfolios contained reflections about students' homes, thoughts and values, goals, likes and abilities, and stories. Students shared the contents of their portfolios via videoconference to partners at distant schools. The portfolios were under continuous construction and reconstruction by the students and served as valuable disclosures of participants' feelings.

We each color-coded contents of interviews and reflections according to recurrent themes, identified change indicators, and came together to achieve consensus. We transferred the contents of students' HyperStudio portfolios to a table with columns of text, images, and researcher comments. In the comments column, the researchers recorded impressions regarding indicators of achievement, self-esteem, and multicultural issues.

Results

We found that students' self-esteem, academic achievement, and multicultural understanding increased in response to Cultural Connections. Four overarching themes emerged from the data: growth, empowerment, comfort with technology, and mentorship. These themes permeated each data source and applied to all participants of the project. Participants grew personally and intellectually. They felt empowered to achieve goals. They became comfortable with technology, and they provided and/or received mentorship. Students mentored and learned from each other. They also had the benefit of receiving mentorship from both their local and distant teachers. Teachers, administrators, and researchers also learned from each other as we shared understandings.

Students' increased self-esteem was indicated by their heightened poise, communication, and leadership skills. One student wrote, "I'm learning to be more open, how to express my thoughts and ideas, and be clear in my speech" (SI/S4/BC). At the beginning of the school year students had used technology for little more than drill and practice. By the end of the school year they described themselves as technologically proficient in multimedia development and telecommunications, a reflection that their teachers corroborated. One student won the district wide multimedia development award.

Language in the pre-project and post-project interviews and reflections indicated transformation from self-belittlement to pride. For instance, early in the project several students compared themselves unfavorably to their distant partners. One student said, "You see them and it's like they have no problems at all" (SI/S5/BC). Another wrote that "Jones students are not nervous in front of the camera and we are" (SI/S7/BC). By the same token, Jones students indicated that Berta Cabaza students seemed more poised and less nervous. By the end of the school year students remarked that they were no longer nervous in front of a group or a camera. A representative comment in response to the question, "What are you learning from Cultural Connections," follows: "I am learning more about myself and being more aware of what and who I am. Also [I am] learning to be grateful for what I have and not be shy or nervous." She also learned to value a distant student partner on an activity; "We are friendly to each other. Both of us are creative" (SR/S7/BC).

Students' increased academic achievement was indicated by comparing scores on the benchmark reading tests administered at Berta Cabaza Middle School. Test scores in November indicated that students in the San Benito teacher's four classes had mastered the same number of reading objectives prior to initiation of Cultural Connections. We identify the four classes as DL for distance learning, class 1, class 2, and class 3. The DL group met several times with their distant partners before the second school benchmarking test was administered in January. The DL class's mean scores improved by 27%. Class 1 scores declined by 4%, class 2 scores increased by 3%, and class 4 increased by 14%. The DL class continued to meet with their distant partners prior to a third testing. When compared with means in November, the third benchmarking test administered in February showed that students in DL improved by 3%, class 1 scores declined by 9%, class 2 scores declined by 7%, and class 4 declined by 2% (see Figure 1).

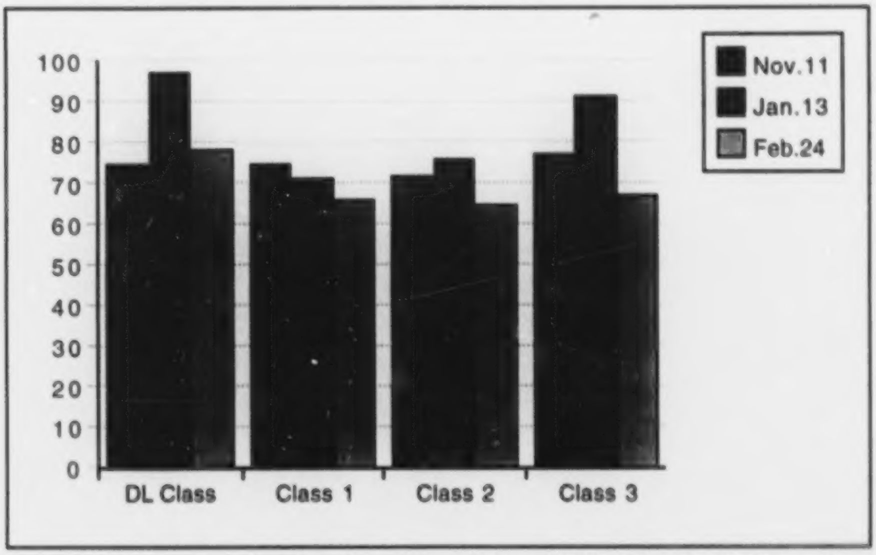

Figure 1. Mastery of reading objectives at Berta Cabaza Middle School in the distance learning class (n = 14), class 1 (n = 22), class 2 (n = 24), and class 3 (n = 24).

In addition to increased reading scores, portfolio analysis revealed that by the end of the year, 11 of the 14 Berta Cabaza students in distance learning intended to go to college and they all expressed interest in a successful career. One student wrote, "My main goal is to graduate from college. I want to be the first from my family to reach this goal. I really have confidence in myself and I believe I can do it. After graduating from college, I am hoping to get a job as a physical therapist" (P/S3/BC).

Students' increased multicultural understanding was indicated by their comments regarding themselves and others in the project. The open-ended question, "What are you learning from meeting with your distant partners for videoconferences?" elicited responses such as, "I'm learning that all people have different kinds of taste and different goals" (SR/S8/BC), "I am learning what they like to do and how they feel about things. I am learning that they have trust to show us their personal things" (SR/S2/BC), and "I am learning more ideas, new ideas, and old ideas. I am learning that many people have great ideas" (SR/S7/BC).

Language regarding distant others changed over time. Early in the project students spoke of their distant partners in generalized terms and emphasized differences. For instance, one student commented, "We're eighth graders and they're fifth graders. They speak differently and are different colors and some of their last names are weird" (SI/S6/BC). Later, their language was more personalized and comments focused on similarities: "We like the same musica and we have almost the same classes, but in different cities. We have the same taste in some food, music, and sports, and I say we all liked distance learning" (SR/S4/BC); and "Chris likes to play around and I do too. He is very funny and he is a student like me" (SR/S3/BC).

After the first meeting in November a young man responded to the question of what was learned from the distance collaboration by commenting that "Ms. Davis's students don't seem to be afraid of the camera, they are not afraid to talk" (SI/S1/BC). The statement is impersonal regarding the distant others and the student paints himself in a negative light compared to them. In May he responded to the same question by writing, "That they learn from us and we learn from them. Also they are very smart kids and I'm learning that I should change my attitude" (SR/S3/BC). This statement is more personal and illustrates both self-respect and respect for distant others.

Portfolios revealed expanded multicultural understanding over time. In one student's HyperStudio™ stack, after describing his family, house, and state, he included Earth as the larger context of his home. He wrote "It [Earth] has different climates, different geographic figures, and different people as in culture." We interpreted this broad and inclusive sense of home as reflecting a vision of world community, and therefore multiculturalism.

Educational Implications

Dewey (1938) defined growth as the ability to secure meaning from experience and to act in ways instrumental to the achievement of worthwhile ends. In Cultural Connections, diverse students across Texas collaborated on multicultural activities which helped them grow in self-esteem, achievement, and multicultural understanding. Cross-classroom collaboration made it possible for young adolescents to expand their world-views in preparation for contributing in our increasingly multicultural environment. This project demonstrates that in networked classrooms students can connect with distant others to learn about and from their perspectives and to increase their multicultural understandings. In addition, distance technologies can foster team teaching across cultures and geographical distances.

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Prediction of and Differences in Computer Use when Universally Available

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Problem

Expectations for faculty members to integrate educational computing into undergraduate teaching are high. Levels of integration among faculty are often low. The universal availability of computers through the adoption of notebook computer for faculty by the University may be one answer. The researcher studied this problem through a survey of faculty at three undergraduate institutions which adopted notebook computers for their faculty and students.

Participants

Longitudinal Study

1. Undergraduate faculty from three small campuses (n = 85).
    - Valley City State University (VCSU) (n = 36)
    - Mayville State University (MaSU) (n = 28)
    - Jamestown College (JC) (n = 21)
2. Respondents answered two questionnaires one year apart
3. Age, Academic Rank, Innovativeness Scale, and Subjective Norms Index determined prior to adoption of notebook computers on any of the campuses.
4. The second questionnaire was used to determine level of computer use.
5. Faculty had had notebooks between six months and one year at the time of the second questionnaire. The three campuses had differing infrastructures and expectations
6. The matched responses from the two surveys were used to determine changes on the three campuses.

Variables

	Dependent	**Independent**	**Demographics**
Phase I	Levels of Computer Use	Subjective Norms Innovativeness	Age Academic Rank
Phase II	University	Level of Computer Use Faculty Stages of Concern Student Technology use Faculty Technology Use Computer Anxiety Frequency of Software Use by Faculty	

Questions

1. What variables might predict computer use by faculty?
2. •Are there differences in the following variables because of the differences in the institution and are there differences over time?
    1. What is the level of computer use among faculty at the three institutions?
    2. What happens to the use of computer technology when notebook computers are available to faculty and or students?
    3. Does the faculty's computer anxiety become lower after faculty have had access to the notebooks for a period of time?
    4. Does the faculty and student access to the notebook computers change the types of concerns expressed in the Stages of Concerns Questionnaire (SoCQ)?

Instruments

- Levels of Computer Use scale (LCU) (Marcinkiewicz & Welliver)
- Subjective Norms Scale (Marcinkiewicz & Regstad)
- Innovativeness Scale (IS) (Hurt, Joseph, & Cook)
- Computer Anxiety Index (CAIN) (Simonson, Maurer, Montag-Torardi & Whitaker)
- Stages of Concerns Questionnaire (Hall, George & Rutherford)

Procedures

Participants completed a *Computer Technology in Teaching* questionnaire composed of the above measures as well as demographic and computer related questions. Faculty received the questionnaire prior to the adoption of notebook computers on three undergraduate campuses. The faculty received the same questionnaire one year later. During the interim between the questionnaires, the three campuses adopted notebook computers for all faculty at varying times. One of the campuses also adopted notebooks for all students.

In the first phase of the study the dependent variable, level of computer use, was determined using responses to the second questionnaire. The independent variables; age, academic rank, innovativeness and subjective norms were drawn from responses to the first questionnaire.

The second phase of the study dealt with technology teaching changes on the three campuses. Indicators of this change included: computer anxiety, faculty and student use of technology, frequency of software use by faculty and level of computer use. Data from the first questionnaire was compared to data from the second questionnaire using a linear model with matched pairs. Only data from faculty who responded to both questionnaires were used.

Analysis

In the first phase of the study the LCU scale determined the criterion variable, level of computer use. The predictor variables, age, academic rank, subjective norms and innovativeness, were compared to the level of computer use. The researcher applied a linear regression to the data. Another linear model was then utilized to determine the effect of university on the level of computer use.

In the second phase of the study, a linear model was also used to compare each of variables. An F test indicated differences in the variables among the campuses and differences over time. T-tests were done between the campuses to determine which of the campuses was responsible for the difference.

Results

In the first phase of the study, the data indicated that one variable-- Subjective Norms Index-- was a significant predictor of the faculty's levels of computer use. Two of the remaining variables, Age and Innovativeness Scale, while were somewhat predictive. The last variable, Academic Rank did not add to the predictive value beyond that indicated by Subjective Norms Index, Innovativeness Scale and Age. The researcher applied a fixed effect for university to the data and the predictive value of Subjective Norms Index was no longer significant. The institution at which the faculty was employed had more of an effect on computer use than did the criterion variables.

Table I Predictors of Computer Use

Variable	t-test statistic	Sig. WO/Effects	Sig. W/Effects
Age	-.567	.057	.093
Innovativeness	1.952	.055	.135
Academic Rank	-.131	.896	.541
Subjective Norms	2.555	.013 *	.295
	*p< .05		

In the second phase of the study, the matched data indicated significant differences in the campuses over time for several variables including; number of different technology uses by faculty and students and the frequency of software use by faculty. Only one variable, number of student required uses of technology, indicated a difference among the campuses as a whole. The data showed significant increases in level of computer use, number of faculty and student technology uses and amount of software use occurred with the VCSU faculty compared to the rest of the respondents. VCSU was also the only campus which had adopted computers for students during the period of the study. See Table II.

Table II. - Differences Among Campuses and Between Pre and Post Scores

				Differences		
Variable	Among all campuses (F test)	In campuses over time (F test)	In VCSU over time (t-test)	Between MaSU & JC (t-test)	Between VCSU & MaSU (t-test)	Between VCSU & JC (t-test)
Computer Anxiety	.822	.188	.617	.106	.119	.771
Level of Use	.430	.092	.048 *	.324	.818	.205
# of Faculty Tech. Uses	.804	.000 ***	.000 ***	.743	.511	.791
# of Student Tech. Uses	.018 *	.000 ***	.000 ***	.571	.008 **	.063
Amount of Faculty Software use	.161	.001 **	.022 *	.058	.253	.315
		*p < .05	**p < .01	***p <.001		

For more information visit this web sight: http://www.vcsu.nodak.edu/offices/titleiii/Links.htm

Stages of Concerns

The following interpretation is one part of the research completed on a problem studied through a survey of faculty employed at three undergraduate institutions which adopted notebook computers for their faculty.

Interpretation - Questionnaire I

Interpreting the Stages of Concerns Questionnaire (SoCQ) involved determining the mean of each of the seven concerns and comparing the changes in those means from 1996-1997 for each of the concerns. Charts detailing levels of each concern are available at this web site http://www.vcsu.nodak.edu/offices/titleiii/Links.htm. The following narrative was written using profile interpretations from the ***Measuring Stages of Concern about the Innovation Manual***, Hall, George and Rutherford.

When the SoCQ was recorded in 1996, prior to the adoption of the notebook computers, faculty from both VCSU and JC had very similar patterns of concern about computer technology. Both groups indicated they knew quiet a lot about computers and were not threatened by them. They also had minimal to no concerns about managing their use but some concern about the consequences of use for students.

MaSU faculty indicated significantly different concerns including: wanting more information about the computers, intense personal concern about computers and their consequences for them, no concerns about the relationship of students to use and they were more likely to be negative toward the innovation.

Interpretation - Questionnaire II

At the time of the second questionnaire in 1997 the patterns had changed, some significantly. JC's pattern remained nearly the same as the previous year. MaSU had moved into a pattern nearly identical to that of VCSU's and JC's from the previous year. MaSU's greatest concerns were about looking for ideas from others, reflecting more a desire to learn from what others know and are doing, rather than concern for collaboration. VCSU, in the second questionnaire, showed significantly different concerns including, a fairly intense involvement with computers and concerns about a collaborative effort in relation to the other high stage concerns Also some individuals indicated that they already know all about computers and have plenty of ideas.

Discussion

The results of the concerns may be explained by the difference in the culture on the three campuses. Information from the questionnaire indicated several differences on the campuses. First, at the time of the first questionnaire in the Spring of 1996 faculty on the VCSU and JC campuses had significantly more experience with computers than did faculty on the MaSU campus. One year later the difference was no longer significant, probably due to the disappearance of the non-user on the MaSU campus. See Table I.

Table III. - Use Level on Campuses

Institution	# 1996	Mean of Computer Use 1996	# 1997	Mean of Computer Use 1997
MaSU	23	2.91	25	3.56
JC	19	3.79	20	3.85
VCSU	35	3.80	33	3.79
Total	77	3.53	78	3.72

Computer Use in Years 0= non-use 1= < 1 year 2= 1-2 years 3= 3-4 years 4= >5 years

Second, the results of the Subjective Norms Survey indicated that VCSU faculty scored significantly higher than the other two campuses. This indicates the faculty on the VCSU campus perceive the expectations of students, peers, and administration are more important than did other faculty in the study. See Table II

Table IV. - Differences in Subjective Norms Score at the Three Institutions

Institution	Subjective Norms Mean	# of Faculty	MaSU Significance	JC Significance	VCSU Significance
MaSU	50.027	26	--	--	--
JC	50.472	21	.004	--	--
VCSU	56.075	37	.001	.004	--
Mean/ Total	52.802	84			

Third, during the period of the study only VCSU adopted notebooks for their students. Also, the infrastructure of the campus included many rooms capable of multimedia (computer) projection and Internet connections by students. The MaSU campus had plans, the year following the study, to adopt notebooks for their students with the same infrastructure changes as VCSU however, JC had no multimedia capable rooms and had no plans for student adoption.

Length of computer use, perceived importance of student, peer and administration expectations of use and student adoption are thought to be responsible for the cultural differences on the campuses. The differing cultures are thought to have influenced the responses to the SoCQ over the one year period of the study.

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Variables Affecting University Academic Achievement in a Distance- Versus a Conventional Education Setting

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Abstract

The aim of this study was to investigate some of the learner variables that may have an influence on the University academic achievement in a distance- versus a conventional education setting.

Descriptive and analytic statistics were used to analyze the data of this study by using "Pearson r", on the one hand, and "F-test", on the other. They revealed the following results:

1- The university academic achievement at both types of education - distance and conventional - have been affected significantly by similar variables. They were:

- *a) Prior high school academic achievement (It has a significant positive correlation with the University academic achievement),*
- *b) Prior high school specialization (It was in favor of science specialization.), and*
- *c) University specialization (It was also in favor of science specialization).*

The gender factor has just affected significantly the university academic achievement in a distance education setting (It was in favor of females).

2- But the University academic achievement in both types of education have not been affected significantly by these variables:

- *a) the locus of control,*
- *b) work responsibility,*
- *c) and the university academic level.*

According to these results, the researcher recommends the university curriculum planners consider courses in science to be compulsory courses regardless of student's specialization. Such courses are expected to force students to use their mental process deeply during learning, hence, to enhance their academic achievement.

Further analysis was done in this research, thus more recommendations were suggested.

Introduction

At any university, administrators always try to maintain a high quality of education. One measure which is still commonly used to asses such quality is academic achievement.

University academic achievement either in a distance or a conventional education setting is affected mainly by two groups of variables as classified by "Robert Gagne". They are: 1) the internal variables, and 2) the external variables (See, Gagne, 1977; Gagne, Briggs, & Wager, 1992).

The internal variables are theoretically related to the learner's characteristics such as intelligence, prior achievement, prior knowledge, aptitudes, attitudes, motivation, locus of control, field dependence and field independence, learning style, work responsibility, socioeconomic class, etc.; Whereas the external variables are basically related to the environment in which learning takes place, such as the physical conditions (i.e., spaces/buildings, halls, studios, galleries, auditoriums), teacher's competency, delivery systems, administration system, planning and designing system, curriculum, mass media, educational aids, budget, etc., (e.g., Barry, 1992; Kaye, and Rumble, 1991; Mayton, 1989; Rezabek, 1992; Sammons, 1988; Verduin & Clark, 1991) (See Figure 1).

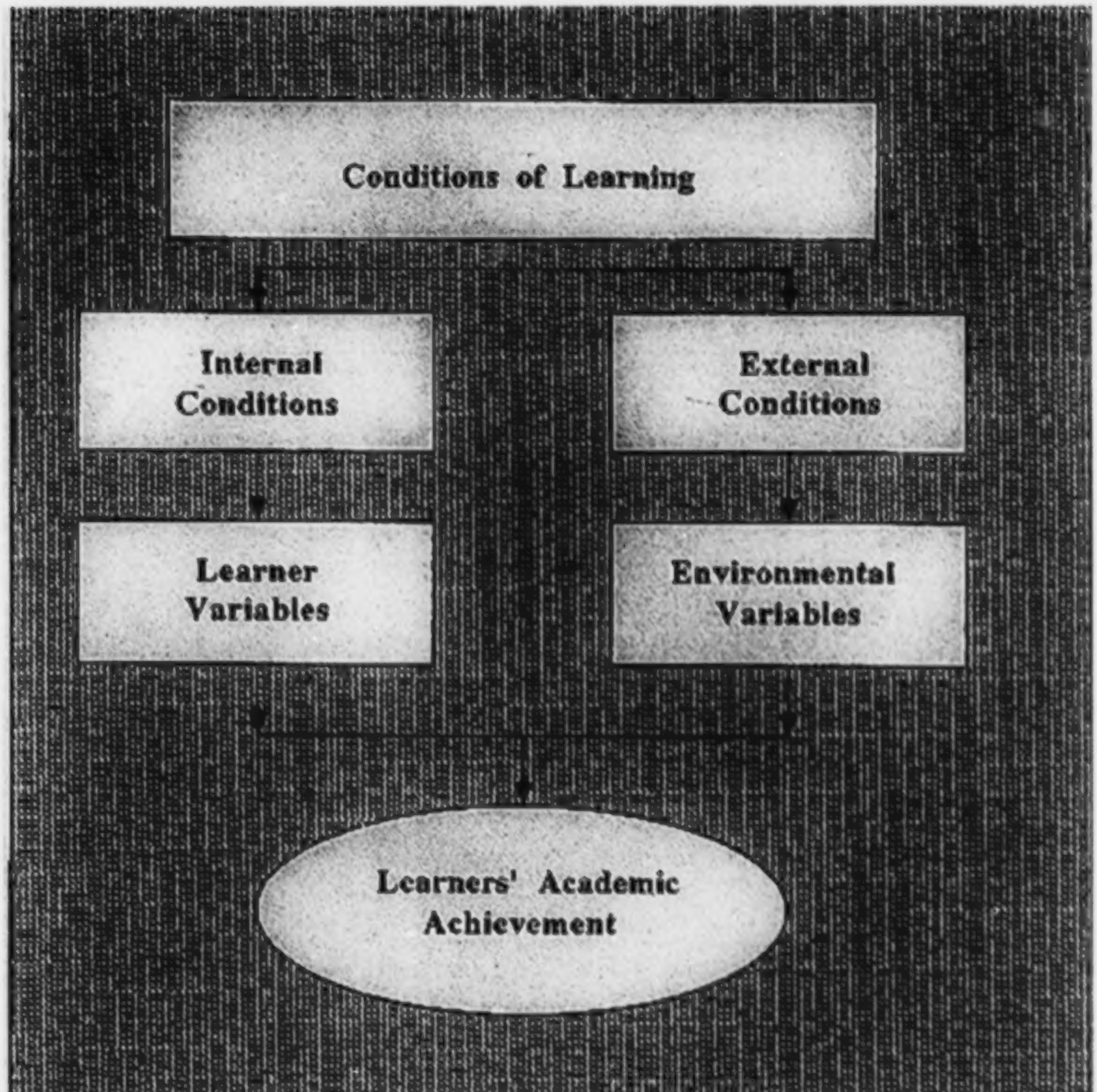
Conditions of Learning
Internal Conditions
External Conditions
Learner Variables
Environmental Variables
Learners' Academic Achievement

Figure 1. Conditions affect learners' academic achievement

Considering that distance education is altogether a different system with more heterogeneous learner characteristics, and a different delivery system from the conventional one (Wilson, 1991), we assume that the academic achievement in a distance education setting will be affected differently compared to that of education in a conventional one.

Some previous studies tested this hypothesis and investigated the effectiveness of distance versus conventional education in terms of students' academic achievement and their attitudes towards learning. Ritchie and Newby (1989), for example, compared two groups of undergraduates: one group studied a course in a conventional education setting, via lecture, and the other group studied the same course in a distance education setting, via television. They found that the first group of conventional education had better achievement than the second group of distance education. They also found that the students in the conventional education setting enjoyed the course more than their counterparts who learned at a distance, via television.

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Smith and McNelis (1993) supported the above results when they took a class of 16 graduates who were studying a requirement course in a distance setting and compared them with the same level class consisting of 12 graduates studying the same course in a conventional education setting. At the end of the course, the assessment of academic achievement showed that the performance of students in a distance education setting was significantly lower than that of their counterparts in a conventional education setting. In addition, the attitudes of distance education students toward learning were negative.

In contrast, Chu and Schram (1976) found that students who learned by television at a distance performed significantly better than their counterparts who learned the same course by lecture in a conventional education setting. They also found that students, at a distance, especially the young students, preferred television to lecture as a tool of instruction. Horowita (1979) also found that students' attitude toward distance education was more positive than toward the conventional one (See, Feasley, 1982).

On the other hand, Haynes & Dillon (1992) failed to find any significant differences in the academic achievement of students who studied at a distance and of their counterparts who studied in a conventional education setting, or in their attitudes towards learning.

By looking at another variable, Field Dependent- versus Field Independent learning, the literature generally indicated that most of distance education learners were field independents and had a preference for the solitary situations and self-defined goals, strategies and reinforcement, and were associated with the idea of self-directness, and autonomy; whereas most of the conventional education learners were field dependents who had a preference for the external controls and more structured environment (See, Rotter, 1966; Wilson, 1991, p.43).

Wilson (Ibid.) had also summarized the results of several research projects related to other characteristics of distance learners compared to conventional ones. He found that distance learners were generally older than the conventional learners, and their age ranged between 20-40, at the average of 37 years. Most of them were professional people who went to school part-time; 66% of them were employed full-time. Most of them were women; however, this seemed to be a trend only in more developed countries. Wilson also found that 84% of distance learners were white, and 75.5% were married. He found that 41% of distance learners were at a distance because going to on-campus classes conflicted with their work, or conflicted with their leisure time (12%), and 51% of them chose distance education to minimize travel, and others because of social, economic or geographical reasons.

From the above results, we can say that the characteristics of learners are clearly different in a distance-compared to a conventional education setting; hence, the academic achievement varies from one situation to another. Since we, in Palestine, are experiencing a new system of education, distance education, and are careful to secure a high quality of education in this new system, the author of this study intended to investigate some of the learner variables that might affect the academic achievement at a distance-compared to a conventional education setting. The variables investigated in this study were: the learner's gender, locus of control, prior high school academic achievement, prior high school specialization, university specialization, university academic level, and work responsibility (See, Figure 2).

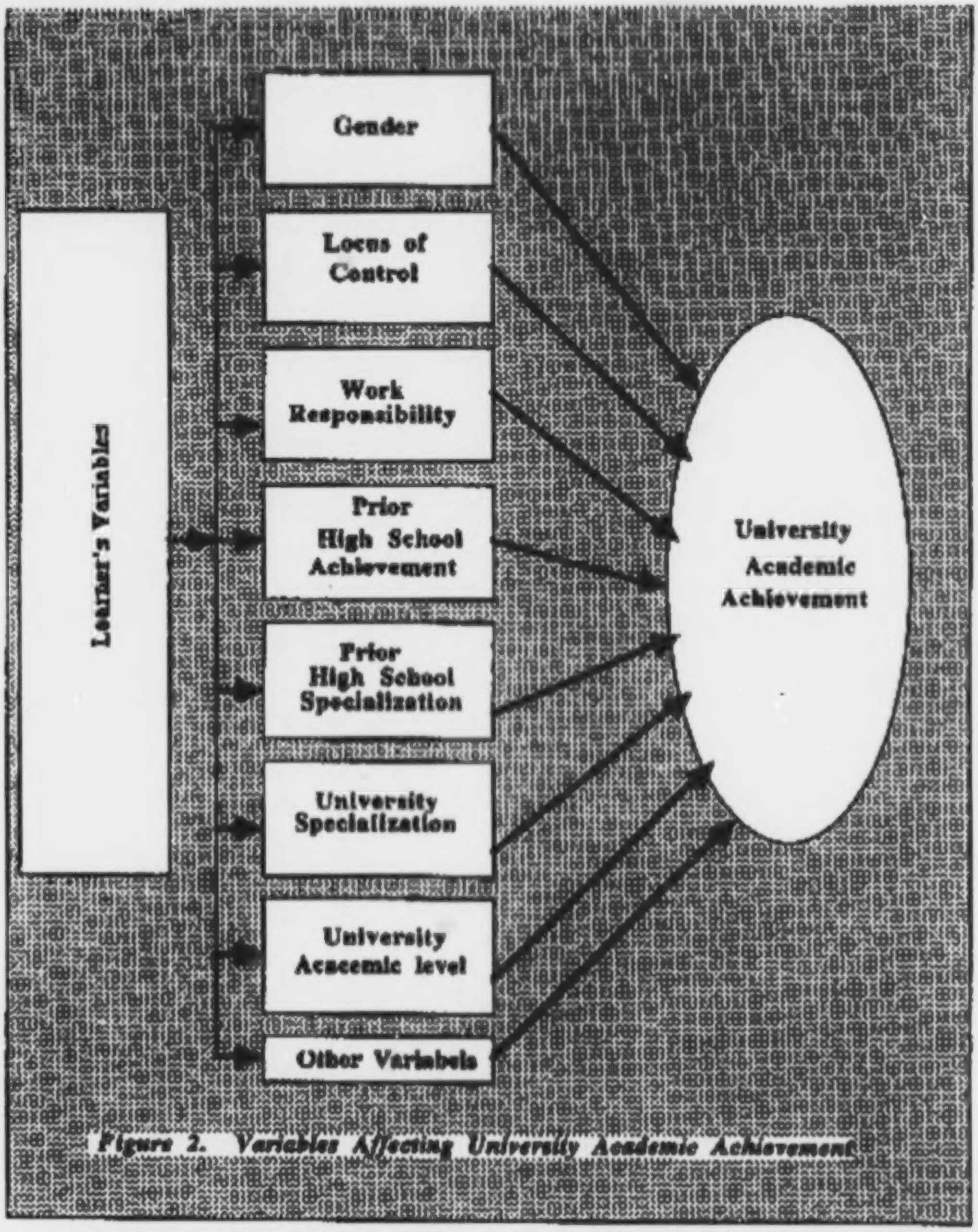
Learner's Variables
Gender
Locus of Control
Work Responsibility
Prior High School Achievement
Prior High School Specialization
University Specialization
University Academic level
Other Variabels
University Academic Achievement

Figure 2. Variables Affecting University Academic Achievement

Therefore, the aim of this study was to investigate the relationship between learner variables and university academic achievement at a distance education university (Al-Quds Open University) and a conventional education university (An-Najah National University).

Importance of research

As mentioned above, we, in Palestine, are experiencing the distance education of Al-Quds Open University, and are careful to establish a high-quality education; therefore, we believe that conducting such research will help us- as instructional designers, to obtain information about our learners' characteristics/variables that might affect their academic achievement, and in what manner, hence, to use this information as a basis for modifying the

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current practice, such as how to modify instructional materials and teaching methods to accommodate the learners' characteristics. This will, consequently, help us to provide high quality education, and to achieve higher educational outcomes. We also hope to draw a model of interaction between learner variables and university academic achievement, and broaden it depending on the findings.

Methodology

Sample:

A random sample of 250 male and female students was taken from Al-Quds Open University branches located in three districts of the northern part of Palestine. It came arbitrarily as follows: Nablus (108), ToulKarem (67), and Jenin (75). In contrast, a random sample of 250 male and female students was taken from An-Najah National University (conventional education) which matched the Al-Quds Open University learners in their specialization (Literature, Science, Education, and Business Administration), and academic level (freshmen, sophomores, juniors, and seniors).

Procedure and Measures:

Rotter's Locus of Control Scale, plus a questionnaire which identified some of the learners' variables, were distributed to collect data from the samples drawn randomly from the registered students, (Fall semester, 1996/1997), from both Universities: Al-Quds Open University (250 students), and An-Najah National University (250 students). The data collected were related to learners' gender, locus of control, the average of government general high school exam (GGHSE), prior high school specialization (Literature, Science), university specialization (Literature, Science, Education, and Business Administration), University academic level (freshmen, sophomores, juniors, and seniors), and work responsibility (work, no work) (See, Figure 2 again). The returned questionnaires were (221) from Al-Quds Open University and (203) from An-Najah National University.

The results were compared to the reported university academic achievement which was expressed in the cumulative average obtained up to the Fall semester 96/97 in both types of University to see if there were a positive and significant relation between the learner variables and university academic achievement.

Results

A correlation coefficient by using (pearson r), and one-way analysis of variance by using "F-test", have revealed the following results:

First: Al-Quds Open University (distance education):

The academic achievement at Al-Quds Open University was significantly affected by the following factors:

1- Gender. It was in favor of females.
2- Prior high school academic achievement. The correlation between the average of government general high school exam and the University academic achievement was ($r=.36$, $p<.01$).
3- Prior high school specialization. It was in favor of science specialization .
4- University specialization. It was in favor of science and literature specializations.

The academic achievement at Al-Quds Open University, however, was not affected significantly by the following factors:

1- work responsibility,
2- Locus of control, or
3- University academic level.

Second: An-Najah National University (conventional education):

The academic achievement at An-Najah National University was significantly affected by the following factors:

1- Prior high school academic achievement. The correlation between the average of government general high school exam and the University academic achievement was ($r=.27$, $p< .01$).

2- Prior high school specialization. It was in favor of science specialization.
3- University specialization. It was also in favor of science specialization.

But the academic achievement at An-Najah National University was not affected significantly by the following factors:

1- Gender,
2- work responsibility,
3- Locus of control, or
4- University academic level (See, Table 1 for statistical information).

Third: A comparison between the results of Al-Quds Open University and An-Najah National University:

By doing a comparison between the results of both types of University: distance education versus conventional, we reached the following results:

1- The gender factor had a significant effect on the university academic achievement in a distance-but not in a conventional education setting. It was in favor of females.

2- The locus of control factor did not have a significant effect on the university academic achievement in both settings - distance and conventional education - but it was found that students of distance education were more internally oriented(E-I = 9.43) than their counterparts of conventional education (E-I = 11.35).

3- Prior high school academic achievement, which was expressed in GGHSE, had a significant effect on the university academic achievement in both settings: distance and conventional education (r=.36 versus r=.24, at P> .01).

4- Prior high school academic achievement, which was expressed in GGHSE, was higher for students in conventional education (82.2%) than their counterparts in distance education (70.1%).

5- Prior high school specialization had a significant effect on the university academic achievement in both settings: distance and conventional education. The significance was in favor of science specialization in both types of education.

6- The university specialization had a significant effect on the university academic achievement in both settings: distance and conventional education. The significance was in favor of science specialization in conventional education, and it was in favor of science and literature in distance education.

7- Each of the following factors had not had a significant effect on the university academic achievement in both educational settings. They are the locus of control, work responsibility, and university academic level (See, Table 1 again).

8- University academic achievement, which was expressed in the University cumulative average, was higher for conventional education students (77.2%) than for their counterparts in distance education (74.6%).

9- Based on the sample of this study, the number of students who held work responsibility was higher in distance education (53) than in conventional one (12). But the number of students in both settings distance and conventional education who did not work during their study was higher (296) than the number of students who did work (65).

Learner Variables

		University Academic Achievement				
		Open University		Conventional University		Comments
Gender	Male	72.6%	* * Sig.	77.1%	Non-sig.	
	Female	76.4%		77.2%		
Locus Of Control (LOC)	External - Internal	r = -.01	Non-sig.	r = +.02	Non-sig.	r. was between (LOC) and Univ. grade average
Work Responsibility	Yes	73.3%	Non-sig.	76.7%	Non-sig.	
	No	75.1%		77.3%		
Prior High School Specialization	Science	77.5%	* * Sig.	78.3%	* * Sig.	
	Literature	73.1%		75.2%		
Prior High School Achievement	Government General High School Exam (OGHSE)	r = .36	* Sig.	r = .27	* Sig.	r. was between (OGHSE) and Univ. grade averag
University Specialization	Science	76.9%	* * Sig.	79.2%	* * Sig.	
	Literature	76.6%		76.7%		
	Education	73.0%		76.8%		
	Business Administration	71.53%		74.5%		
University Academic Level	Freshmen	73.7%	Non-Sig.	No grades reported	Non- Sig.	
	Sophomores	74.5%		76.8%		
	Juniors	76.6%		77.2%		
	Seniors	76.8%		77.7%		

* * P< .001
* P< .01

Table1: The impact of learner variables on University academic achievement in a Distance-versus a Conventional education setting.

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Discussion and Recommendations

It seems that the most important result of this study was that academic achievement in both types of university, open and conventional one, was affected similarly by the same variables of learner, with a slight difference. This is true at least in the Palestinian case. We could say according to the findings of this research that the learners who had high grades in high school with a scientific background are the most successful students in both types of University. Even at the University levels, learners who specialized in science achieved higher grades than those who specialized in education, business administration, or literature. While it is impossible to direct all students to specialize in science for many reasons including the integration of the society, it is worthwhile to modify our curriculum, either at high school or university level, to include more topics in science besides other topics. It seems that the topics of science with all symbols, formulas, and logical issues have a positive effect in activating deep mental processes than the other topics, thus increasing students' learning achievement. Well, more research is recommended on this issue to confirm such a result.

The interesting result is that the gender factor was affecting university academic achievement just in a distance education setting not in a conventional one. It was in favor of females. This result was supported by Darwazeh and Abu-Amsheh (1993) when they found that the academic achievement of females was higher than males who study in Al-Quds Open University but not in An-Najah National University, the conventional one. It seems that the nature of the distance educational system, which doesn't demand that their learners attend the university on a systematic schedule helps females more than males to feel free in organizing their schedule at their convenience, so they can manage the house responsibility and their studies at the same time. This could be true especially for married females who hold responsibilities for their homes and families. However, more research is recommended on this issue.

With respect to the prior high school academic achievement which is expressed in GGHSE, it seems that this factor is a good predictor of the university academic achievement either in the Open University or in the conventional one. At the same time, it does not hurt to use other factors besides the GGHSE to predict university academic achievement, such as the university entrance exam, or ability tests, especially in the conventional universities which require their applicants to meet certain conditions in order to be university candidates.

With respect to the locus of control, the study found that the Open University learners were more internally oriented (E-I = 9.43) than the learners of the conventional one (E-I = 11.35). This result does make sense, because most of previous research summarized by Wilson (1991), found that the distance learners were mainly field independents rather than field dependents. This means, to some extent, that they are self-directed learners and have control over their learning goals, strategies, and structure. Well, this kind of result needs to be tested further.

Looking at the result which indicated that the academic achievement at An-Najah National University was higher (x= 77.2%) than the academic achievement at Al-Quds Open University (x=74.6%), it makes sense at least in Palestine, because the conventional universities in Palestine demand their applicants to meet certain conditions in order to be university candidates, and one of these conditions is a high average of GGHSE, whereas Al-Quds Open university does not demand such a condition. Accordingly, the conventional university learners are considered to be elite learners from the beginning, in terms of their academic achievement, whereas it is not the case in Al-Quds Open University. But the surprising result is that the academic achievement of learners who entered An-Najah National University with a GGHSE average of (82.2%) has been declined after entering the University and became (77.2%), whereas the academic achievement of learners who entered Al-Quds Open University with a GGHSE average (70.1%) has been enhanced after entering the University (74.6%). This result could be due to the nature of the instructional system at Al-Quds Open University which gives learners more freedom and control over their learning, whereas the nature of the instructional system at An-Najah National University gives teachers more responsibility and control over learners' learning. It is well known in education that the learner-centered system is more effective than the teacher-centered system especially at higher level of learning. This kind of observation leads us to raise a recommendation to the conventional university administrators in Palestine to modify their instructional system and let the teachers give their students more opportunities to get involved in the learning process, thus to interact effectively in the instructional process, than is now the case..

To sum up, more research is recommended to investigate other learner variables, such as academic needs achievement, learning styles, time commitment, perception to the instructional materials, etc., and to investigate some of the external variables related to the instructional environment and which have an influence on students' academic achievement.

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START (Student Trainers as Resource Technologists): An Alternative Approach To Technology Integration

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The Office of Technology Assessment (OTA; 1995) recently reported that U. S. schools have over 5.8 million computers available for instruction. Over the past decade the number of students per computer has gone from 125 to less than 10 (Sandholtz, Ringstaff, & Dwyer, 1997). Although administrators have generally welcomed new technology into their schools, the introduction of computers into individual classrooms has created challenges for both experienced and inexperienced teachers (Becker, 1993). Many common barriers to technology integration have been identified including limited equipment, training, and time (Hadley & Sheingold, 1993; OTA, 1995; Ringstaff & Yocam, 1994), as well as teachers' resistance to change and their current pedagogical beliefs (Gilmore, 1995; Hancock & Betts, 1994; Hannafin & Savenye, 1993). Brickner (1995) suggested that these obstacles be categorized as first- or second-order barriers to change, defined as "the extrinsic and intrinsic factors that affect a teacher's innovation implementation efforts" (p. xvii). First-order barriers are extrinsic to teachers and include lack of access to computers, access to software, time to plan instruction, and technical and administrative support. Second-order barriers are intrinsic to teachers and include beliefs about teaching, beliefs about computers, organizational context, lack of instructional models, and unwillingness to change. While many of the first-order barriers may be eliminated through the procurement of additional resources and the use of traditional training methods, second-order barriers are more likely to persist, requiring different resources and training strategies.

According to Sorge, Russell, Mandell, & Brickner (1995), effective technology integration training should, among other things, provide assistance on "the process of implementing technology" (1995, p. 29, emphasis added). Although the implementation stage is generally recognized as being key to effective change efforts (Fullan & Hargreaves, 1992; Herriott & Gross, 1979), current methods of teacher training often fail to address this stage. In many instances, "technology staff development for teachers has been fragmented, not context-specific, and without ongoing support" (Meltzer & Sherman, 1997, p. 56).

A body of literature is accumulating that suggests that changes in methods of staff development may help alleviate second-order barriers to computer integration (Ringstaff, Sandholtz & Dwyer, 1991; Ringstaff & Yocam, 1994; Ritchie & Wiburg, 1994). A small part of this literature advocates the use of students as an integral part of the technology training process. Not only can the students learn computer skills alongside their teachers, but they can provide on-going technical and emotional support as the teacher begins the implementation process within her curriculum. The Apple Classroom of Tomorrow (ACOT) project illustrates how using student technology expertise in the classroom may effectively address implementation barriers. For example, Ringstaff et al. (1991) stated that "while many teachers at first questioned the value of using students as teachers and wondered how it would affect learning, teachers soon realized that the benefits of this role shift went far beyond saving them time" (p. 12). Teachers saw change not only within their students but within themselves. Teachers often took the role of facilitators, while students played the role of experts (Ringstaff & Yocam, 1994). As the teachers became more confident with this pedagogical shift, learning to integrate technology became more relevant. "Only classroom practice (i.e., working with children) provides relevance and purpose to access skills and information and, therefore, has the potential for long-term changes in teacher behaviors" (Gilmore, 1995, p. 254).

Background and Purpose of the Study

In the fall of 1995, faculty and graduate students at a midwestern university initiated an alternative approach to teacher technology development at a local elementary school (referred to here as Midland Elementary).

For the past two years, all students (grades 1-5) have received computer training at least one day a week from the media specialist, university personnel, and/or volunteers. An additional after-school training program was initiated in the fall of 1996 to train a small group of students to serve as technology tutors (named by students as the Midland Computer Masters or "MCMs"). This group of 18 students met one hour/week to receive specialized training on computer hardware and software. The purpose of this ongoing project is threefold: 1) to develop a successful technology program in an elementary school setting, 2) to target students as technology leaders as a way to increase self-esteem, leadership, technology, and collaborative skills, and 3) to encourage the use of available technologies among teachers by providing readily available "experts."

The current study represents the second in a series of year long studies that have taken place at the school, investigating the effectiveness of our integration efforts. Results from the first year were used to inform planning, implementation, and evaluation strategies used in the current study. The primary research question that guided our study was, *"What impact does specialized student training have on teachers, students, and the school?"* Specifically, we asked:

- What changes occur in teachers' uses of technology as well as their reasons for use?
- What changes occur in students' confidence with technology, basic computer skills, and self-esteem?
- What changes occur in the school's technology culture, including use of student trainers?

Methods

We used qualitative methods to examine changes in the teachers,' students,' and school's use of technology. We examined teachers' and students' uses at the beginning of the year, prior to implementing our after-school training program, then examined technology use at the end of the year to document the types of changes (if any) that had occurred. In addition, teachers' and students' attitudes toward technology use were assessed, as well as their perceptions of the changes that had occurred in themselves, their students/teachers, and/or the school. These perceptions were then compared to the researchers' perceptions of change.

Role of the Researchers

The researchers involved in this study included 1 faculty member, 5 graduate, and 2 undergraduate students from the local university. Three of the graduate students had been with the project since its inception; the faculty member and undergraduates joined at the start of the second year. Five Midland teachers and the librarian served as "co-chairs" during the second year, jointly overseeing, with a university team member, various components of the project (planning, implementation, funding, and research). Co-chairs met monthly to plan training and implementation strategies and to determine how to solve logistical and other problems.

Description of Site and Participants

Midland Elementary, a local Professional Development School (PDS), is one of 11 elementary schools in the corporation with a total enrollment of 281 students, representing approximately 201 families. The student body consists of a mixture of lower and middle class students, including 31 students with special needs. The participants in the study included all 13 teachers (2 teachers each in grades K-5 with an additional teacher in a multi-age primary classroom), 18 students selected as tutors, the librarian, and the principal. Table 1 summarizes demographic information for Midland staff participants (using pseudonyms).

At the time of the study, Midland's technology resources were limited. Each teacher had one Power Mac in his/her classroom. To facilitate student training during Tech Time (weekly 1/2 hour sessions for all students grades 1-5) and MCMs (after school training for 18 technology tutors), teachers had to roll their computers, on carts, to the library on Wednesday afternoons so they would be available for Tech Time on Thursdays and Fridays. Thus, computers were in the classrooms three days a week and in the library the other two.

Table 1. Demographics of Midland Staff Members.

Participant	Role/Grade	Years of Experience
Bea	Teacher/K	10
Chris	Teacher/1	4
Ethel	Teacher/3	40
Janet	Teacher/K	8
Janette	Teacher/MAP (1-2)	24
Julie	Teacher/2	5
Lana	Teacher/MAP (1-2)	30
Marlene	Teacher/5	30
Micelle	Teacher/MAI (3-5)	17
Molly	Teacher/MAI[b] (3-5)	25
Patty	Teacher/MAP[a] (1-2)	26
Polly	Teacher/MAI (3-5)	14
Stephan	Teacher/4	23
		Average =18 years
Nancy	Media Specialist	5
Deborah	Principal	10

Note. [a]Multi-age Primary. [b]Multi-age Intermediate

Procedures

In the fall of 1996, Midland classroom teachers in grades 3-5 were asked to refer students for the after-school technology program based on students' current computer skills (both high and low levels were included), ability to quickly learn computer skills, and ability to help others learn computer skills. Initially, 18 students were invited to participate. This included 5 third, 6 fourth, and 7 fifth graders and consisted of 10 girls and 8 boys. Ten of the students met in the school's library for an hour each week on Thursdays; the other 8 students met on Tuesdays in the central administration's Mac lab. Three second graders (a girl and 2 boys) joined the Tuesday group in the spring. Students learned about desktop management, word processing and drawing applications, HyperStudio stack development, and the Internet.

Data Collection

To investigate changes that occurred over the year, survey and interview data were collected from both student trainers and teachers in the fall and the spring.

Data sources—students

Harter's Self-Perception Profile (Harter, 1984) was administered to assess changes in student trainers' self-esteem. The 20 student trainers were interviewed to assess changing attitudes toward computer technology as well as toward the after-school program. Technology projects (e.g., word processed stories, HyperStudio stacks) indicated changes in technology skills and served as triangulation data.

Data sources—teachers

All 13 teachers completed an open-ended survey in the fall to assess current uses of, and attitudes toward, computer technology. Seven teachers were interviewed to gather additional data. Follow-up surveys were gathered and interviews conducted with 12 teachers, as well as the principal and media specialist, in the spring (the one non-responding teacher was retiring at the end of the year and was a non-computer user). Open-ended statements describing current technology use (referred to as "workshop reflections") were also collected at two technology in-services held during the year.

Data Analysis

The university research team worked collectively to analyze the data. Initially, each researcher took responsibility for analyzing one set of data, (e.g., student surveys), employing a constant comparative method of analysis to identify tentative patterns in the data. After sharing early codings and themes, we exchanged data sets and performed similar analyses on a team member's data set. Regular meetings were held throughout the year to compare and synthesize emerging findings across data sources.

Interpretation of Results

Guided by the overarching research question, "What impact does specialized training have on teachers, students, and the school?" we examined changes that occurred in classroom teachers (amount and types of uses of technology, reasons for use), student trainers (confidence with technology, technology skills, and self-esteem), and the school (technology culture, use of student trainers). Data were collected from five sources (teacher and student interviews and surveys, and teacher workshop reflections) in the fall and spring so that changes in use could be assessed across time. We examined changes in teachers and students first, then drew on this information to describe changes that occurred at the school level.

Teacher Changes

Teachers' use of technology was reviewed both in terms of how (the purpose to which it was directed) and why technology was used (the supporting rationale).

Teacher Use--*How* Technology Was Used

Teacher use was classified into two main types: professional and instructional. *Professional* uses included teachers' use of the computer to communicate with parents through newsletters, to create instructional materials, and to locate and/or organize professional or instructional information. *Instructional* uses of the computer included any use in which students interacted with computer programs, either directly in the form of some type of CAI program, instructional game, or tool application (e.g., word processing, HyperStudio), or indirectly in which the teacher used a CD-ROM or laserdisc to present information to the students.

Professional uses of technology. In the fall, nine of the 13 teachers mentioned that they used the computer primarily for writing newsletters and creating instructional materials. Locating and organizing information via databases (n=1), CD-ROM resources (n=1), and by creating tables in Word (n= 5) were noted less frequently.

In the spring, these same, as well as additional, uses of the computer were reported by more teachers. Twelve teachers reported using the computer to write newsletters; 12 used it to create instructional materials; 4 reported using databases, and 6 used CD-ROM information resources. Additionally, 11 teachers were using the computer for some type of record keeping and 3 teachers noted the use of e-mail. Thus, more teachers were making use of more applications than noted in the fall. As Nancy, the media specialist pointed out, " The staff is using the computer much more. And more members of the staff."

However, it is important to remember that this data indicates the types of uses teachers made of the computer and not the amount of use. Survey data indicates that teachers' use increased slightly from an average of 2.4 hours a week to approximately 5.5 hours a week. In addition, teachers' ratings of comfort levels with computer applications, on a scale from 1 (not comfortable) to 4 (very comfortable), increased for word processing (from 3.3 to 3.9), yet showed little change for databases, spreadsheets, or graphics.

Instructional uses of technology. In the fall, ten of the 13 teachers mentioned some type of instructional use of the computer. Classroom uses revolved primarily around the use of prepackaged CAI programs and computer games (n=7), and these uses occurred most frequently within the context of learning centers (referred to here as stations). Five teachers mentioned using CD-ROMS or laserdiscs in instruction, 3 teachers noted students' use of word processing, and 3 teachers noted students' use of HyperStudio.

In the spring, there was only one teacher who did not mention using the computer for instructional purposes. Ten teachers mentioned using various CAI programs, nine teachers were noted as using instructional games, and six teachers were noted as using CD-ROM programs. Additionally, 11 teachers mentioned that their students were using word processing for creative writing, and seven teachers noted the use of HyperStudio for projects and reports. Six teachers noted that their students were using graphics applications to enhance their reports. A couple of teachers also noted that their students were occasionally using other applications, specifically the Internet, databases, and spreadsheets.

In comparison to the fall, instructional uses were more varied (additional applications were mentioned) and more common (more teachers were using more applications) in the spring. However the primary context for use continued to be that of a learning station. This finding from teacher interviews was supported by the principal's observation. When asked to describe how her staff was using technology, the principal described two primary types of use: In a lot of classrooms, kind of the classic example of "if you get your work done you can have computer time." Others will use it as a station during discovery or center time.

Thus our results suggest that by the end of the 1997-98 school year the teachers had changed, to some extent, in terms of what they used, but not in terms of how that use was structured. Learning stations, or independent remedial or enrichment work, appeared to be the main types of uses of technology. These uses seemed to fit relatively easily into teachers' current practices and seemed to support the teachers' ideas about the type of instruction needed to reach their students. This finding is similar to that reported in the literature: teachers' initial uses of computers tend to be directed toward supporting traditional goals (Hadley & Sheingold, 1993; Marcinkiewicz, 1993). Becker (1991) suggested that this is true even for teachers with an abundance of equipment. Teachers favored traditional programs of instruction that were "not very different than what would be followed without the computer" (p. 8).

Teacher Use--*Why* Technology Was Used

Reasons for professional use. Teachers used technology because they perceived that it increased their efficiency, enhanced their professional image, and/or increased the appeal or effectiveness of their instruction. The following quotes exemplify these perceptions:

- *efficiency*: A computer is so much easier (than hand typing)--you type it, file it, and then pull it up later. You don't have to take so much time (Lana, fall).
- *professional image*: I like to do books for the kids, and the print is so much better than my handwriting. I think it makes things look neater, sharper, and more professional (Dea, spring).
- *appeal*: I create a lot of my own materials--if I'm going to make up math story problems I'll use the kids names . . . so I can make things closer to their interests (Julie, fall).
- *effectiveness*: We can pick a theme, or a topic in science, and we'll find pictures and short videos on the laserdisc to support the ideas, which is wonderful (Molly, spring).

Reasons for instructional use. We analyzed the reasons teachers gave for using technology in instruction and identified five main reasons for use: 1) to reward good behavior or effort, 2) to build and/or reinforce skills, 3) to enrich or enhance the current curriculum, 4) to expand (add more depth or related study to) the curriculum and 5) to change or transform the curriculum. Although none of the teachers actually described using technology to change the curriculum, this category was included based on the literature, as well as on our observation that some teachers seemed to be moving in this direction. The majority of uses that teachers described centered around the first three reasons. Each reason for use is exemplified below with a quote from one of the teachers:

- *Reward*: It's a good motivator to say, "I'll make sure you get to be first on the computer if you will just do this." I have one child who it works as a real good incentive for him because he really just flat out wants to refuse to work and so I can use the computer as an incentive (Julie, fall).
- *Reinforce*: Using the computer to expand on ideas helps kids understand and retain information, helps kids review skills (Patty, spring).
- *Enrich*: Technology integration means supporting my teaching and ideas and the program that I'm in. It's nice to be able to (use) the CD-ROMs and things that are already prepared. Some of them do a nice job of integrating ideas. It's nice sometimes to have something right on hand that you don't have to spend time developing (Michelle, spring).
- *Expand*: Technology integration means that all (students) can use the computer in a way where the technology, whatever it may be, in a way that helps foster a better learning experience or a more creative xperience (Nancy, spring).
- *Change*: Technology integration means using technology to develop the curriculum, to continually create new curriculum (Marlene, fall, 1997).

Teachers at Midland typically did not describe using technology to provide part of the "core" curriculum but rather to provide additional or more motivating ways for students to learn skills or topics that had already been introduced. Figure 1 summarizes our interpretation of each teacher's primary reason(s) for use based on interview and survey data, and also helps to illustrate where the school was, as a whole, in terms of use. We observed little change in teachers' reasons for use from fall to spring. Given that technology use is likely to represent, rather than shape, beliefs about teaching and learning, major change was not expected.

Figure 1. Teachers' primary reasons for using technology in the classroom.

Teacher/ Type of use	Reward/ Motivate	Reinforce/ Build Skills	Enrich/ Enhance	Expand/ Extend	Change/ Transform
Bea			XXX		
Chris		XXX			
Ethel	non-user				
Janet		XXX			
Janette			XXX		
Julie	XX	X			
Lana			XXX		
Marlene				XXX	
Michelle			XXX		
Molly			XXX		
Patty	X	XXX			
Polly			XXX		
Stephan			XX	X	
Nancy			XX	X	

We think of these five types of uses (e.g., reward, reinforce, enrich, expand, change) as being on a continuum with higher levels of integration on the right. Whereas a "reward" type of use can occur completely outside the curriculum, a "change" type of use leads to an evolving curriculum--one that is continually being invented as new opportunities and possibilities arise (Hooper & Reiber, 1995). In this study, most teachers emphasized only one type of use, although one teacher (Patty) frequently mentioned both motivational and enrichment uses, as noted by the extra X in the figure.

Summary

Based solely on the number of teachers who used the computer, and the number of ways they reported using it, our results suggest that there was an increase in technology use by teachers, for both professional and instructional purposes, from fall to spring. Yet these increases in use did not appear to be accompanied by any related shifts in instructional approaches or processes. Patty's quote illustrates how most teachers used technology to support current curricula:

> I like to see the technology brought in and related to what I'm doing. And I think it takes a well planned teacher to do that. I think I need to plan for how could this computer help me expand on this idea or how could the computer help get this scientific term ingrained in their little minds? How can tech help review this math skill that I have already taught them?

In general, the changes that teachers noted in themselves related to increases in comfort, confidence, and interest rather than to changes in teaching methods or classroom organization. As Molly explained in the fall: "As far as classroom processes, (they) haven't changed at all" and again in the spring, "Technology hasn't changed the way I teach. I look at technology as a support to the way I teach."

Student Changes

Differences between students' pre and post Self-Perception Profiles were not statistically significant ($t = .029$; $p > .05$), yet survey and interview data from both teachers and students provided evidence of change in students' confidence, technology skills, and self-esteem. Comments were classified as related to *confidence* if they referred to students' comfort with technology, with helping others with technology, and/or with a growing conviction of their technology skills. Comments were classified as related to increased technology *skills* if they referred to new tasks that students could complete on the computer. Comments were classified as related to *self-esteem* if they referred to children's increased sense of self-worth or pride in their accomplishments.

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Increased Confidence

Students made many comments that reflected their growing confidence with technology. When asked the question "I used to (do something in regard to technology), but now I (do something else concerning technology)," nearly all of the students answered in a way that suggested an increase in both skills and confidence. For example, Anna remarked:

> I used to not go on computers and I used to think that computers were for the brainy kids and they weren't for me. And they were too hard for me. But now I know that computers can be fun sometimes and they aren't always hard and they aren't for brainy kids, they can also be for me too.

> Ashley expressed a similar idea:

> I used to be like, "It's never gonna happen, I'm never gonna understand technology. Computers? Too hard." But now I'm like, "Computers? Easy. HyperStudio, Claris Works...They're just like the basics." They used to be really hard for me, but now they're really easy.

Students were generally not afraid to help when their teachers experienced difficulties with the computer, even if they were not certain how to fix the problem themselves. Tony, a third grader said, "...she goes 'Does anybody know how to turn the computer off?' and I go 'I'll try to.' So I tried it and it worked." Anna commented, "Sometimes the teachers get stuck on the computer and I'm like 'Well, maybe if you take it this way, it'll be able to work.' And then they try it and sometimes it works and sometimes it doesn't."

Students also liked being able to help the other students in their classrooms. Comments such as Erin's: "I like doing it (the MCM program) because I get to learn new things and then I can show it to other kids," and Danielle's: "...I'll help them. Sometimes I'll teach them new things like on databases and spreadsheets. I'll teach a little bit on the Quick Take camera. Just simple things like that" both illustrate the confidence students displayed when helping others.

Teachers also noted how students' confidence had grown. As Janette pointed out, "The children are fearless. They are not afraid to try things and they genuinely enjoy it (technology)." Stephan noted how "several students helped other students with computer skills." The principal indicated that she had observed increases in "students' comfort level in knowing some of the different software packages and how to use them."

Increased Computer Skills

Most likely, the increases in students' confidence were related to their growing skill levels. Students were certain that they learned a great deal as MCMs. When asked at the end of the year what they had learned, students made comments such as, "Everything. I never knew anything about a computer" (Shanea). Jason described a few of the specific skills he had learned, "I've learned lots of things like you can get into writing Claris Works, you can get a picture from up there, cut it, then go back into HyperStudio and if they don't have that same picture you can paste it on there and then you have a picture from Claris Works. I've just learned a lot of things." Laura also listed some of the specific skills she had learned: "...how to do some stuff like with the ZapShot camera and load it on to the computer. And we're starting to use the Internet and how to find things on the Internet." Similar comments were made by nearly all students interviewed.

Teachers also commented on the growing skill level of the students. Nancy explained, " We are seeing a lot more usage of the computers. As a whole the students are learning, understanding it better, the students know (more), than for the most part, the staff members."

Increased Self-Esteem

Although students did not make any direct comments about increases in self-esteem, we can infer this from the way they described their growing skills and confidence. When Anna stated how "technology is not just for brainy kids but for me too" she conveyed pride in what she had accomplished. When Ashley described how she "caught on pretty quickly" and how she "just gets it right" when she guesses what to do, she also expressed a sense of pride. Nick described how he felt special because of his new skills: "I used to only do regular stuff on the computer that everybody knows but now I do more higher level technology stuff because I know more."

Teachers made a number of comments about how students, particularly their "at risk" or "difficult" students, had excelled in the technology program and had experienced increased self-esteem. For example, Marlene noted:

> Kids can be successful even if they have not been successful with the regular curriculum. (Technology) improves the self-concepts of all students, especially at risk students. . . I think we should continue the Tech program. The children enjoy it, they feel proud, they feel successful. One of my students goes to another classroom and helps another teacher, which makes him (work) better.
>
> Molly described it this way:
>
> I've found that many of our kids who have a handicap are very successful on computers and it makes them very confident, happy, and proud. It's just really fun to watch them. In many cases those kids turn around and become helpers to students that you would assume would catch on immediately.

School Changes

The principal and the teachers perceived that the school, as a whole, had made some important changes in technology use. At the start of the study (fall of 1996), teachers were asked to describe the role that technology had played at Midland in the past. Many teachers described the limited role that technology had played to date. Others elaborated, indicating that the primary use of the computer had been in the form of drill and practice programs, instructional games, and "a little" word processing. In the spring, teachers made the following comparisons to describe their perceptions of how technology's role had changed:

> Patty: We used to use computers sporadically but now we have a plan.
> Julie: We used to have limited use, now we integrate with instruction.
> Lana: We used to (just) talk about it, but now we use it.
> Dea: We used to let the computer sit; now we have instructional programs on it for the kids.
> Marlene: We used to play games, now we enrich all areas of the curriculum.
> Polly: We used to view computers as reward for finishing work, now see them as more of a tool to assist students.
> Deborah: "We've probably grown 3, 4, 5 years this year, in comparison to past years."

These changes that the teachers and principal noted (in planning, frequency of use, and reasons for use) were perceived as contributing to a climate of change at Midland, with a focus on technology. As Marlene noted, "I think it (our technology focus) has helped to bring the staff together and we feel a commonality." The principal stated that the changes/growth at the school were due, not to specific factors, but to this change in culture, "It's not just the MCMs and Tech Friday. I think it's an entire package, a focus, a concerted effort, and also a breaking down of barriers. . . . I'm not sure what the catalyst was, but I think it's probably a brew that mixes."

As a whole, teachers in the school seemed to be making a conscious effort to include the computer in their curricula in whatever ways fit their teaching styles best--whether as a remedial or reward tool, or as part of an instructional center. Talking about, and working toward using the computer, had become a natural part of the school culture. This changing culture was also reflected in teachers' attitudes toward, and increased uses of, the MCMs as described in the next section.

Attitudes Toward and Use of Student Trainers (MCMs)

Teachers' responses to the MCM program were positive throughout the year. In the initial interview Patty commented, "I think the Tech program has had the biggest influence on our children's ability to use the computers." In the spring Michelle said, "I think what we're doing is really good. I'm hoping it will be something that over the next few years will really grow."

As the year progressed, teacher use of the MCMs increased. At the beginning of the year, teachers reported no use of the student helpers. By the end of the year, teachers indicated that the MCMs were being used by both students and teachers. Janet reported, "I have an older student [a fifth grader] working with one of my kindergartners, teaching her HyperStudio." Julie, the 2nd grade teacher commented, "We used to rely on teachers to be experts, but now the MCMs are knowledgeable." One teacher described how she, herself, had used a student trainer:

> We had to bring (to the second inservice) something that we had done using it (HyperStudio). I hadn't done anything on it. I thought "Oh great, what am I going to do?" So I grabbed a 5th grader who is excellent in it. She was wonderful. I was absolutely amazed at her knowledge on it. I learned a lot from her and I think that's good that the kids see that we don't know everything and that must make them feel kind of good that they can help us out too. (ESL Teacher)

Teachers' positive attitudes toward the program may also have been enhanced as they began to see additional benefits of the Tech program. Student enthusiasm and computer expertise increased. Students also began solving technology related problems.

Perceptions of the Students

Based on teachers' comments, technology use at Midland had changed substantially during the year. However, teachers tended to perceive greater use (by both teachers and students) than students did. For example, one teacher stated, "My class uses computers, CD players, laser disc players, and ZapShot cameras throughout the curriculum," yet one of her students said: "The kids don't use that much technology anymore, other than games. For typing reports and stuff like that we don't really use the classroom computer. It just sits there most of the time." Similar comments were made by other students:

> We've used (computers) during my free time--which is hardly ever (Ashley).
> I don't ever use it for my school work. Once we did, but we don't do it anymore. We used to play on the computer at recess in the winter (Shanea).

It's not clear why students perceived different levels of use than the teachers. Maybe because students were so anxious to use the computers they thought that they never got to use them enough. Or maybe the teachers' perceptions/definitions of use were broader than the students. Whatever the reason, we realize that, in the future, we need to expand our data collection methods to include classroom observations. These will enable us to verify how often students and teachers are using the computers as well as how they are being used.

Perceptions of the Researchers

Teachers at Midland defined technology integration differently than the researchers. Whereas our definition was directed more toward "changing" the curriculum, teachers in this study typically defined technology integration as using technology "to present, reinforce, or motivate children to interact with the (current) curriculum." For example, a teacher who stated that she used technology to "enrich" the curriculum, elaborated by explaining that technology provided an additional way for her to present the curriculum to the students. Another teacher defined technology integration as "using technology to enhance what you are teaching; helping students learn what I need to teach them." In these cases, enrich meant providing students with more of the same curriculum as opposed to taking the students beyond what was currently prescribed to explore new topics or old topics in more depth and with greater involvement. "I'm not dependent upon the computer to teach them something but more (to) reinforce things that I've taught."

This approach to technology integration is consistent with how other teachers, in the literature, have described "getting started" with technology. Dwyer (1996) reported that when teachers started using technology in the ACOT classrooms there was, initially, very little change in classroom practice. However, as teachers gained confidence and skill with the technology, and as they witnessed changes in their students' motivation, performances, and interactions with each other, a shift occurred:

> Teachers' own growing prowess, coupled with observable changes in their students' work and forms of interaction, opened the staff to the possibilities of redefining how they went about providing opportunities

> for students to learn. Technology was acknowledged as the catalyst for new perspectives and practices (p. 24).

Midland School has only recently embarked on the technology change process. The teachers' current approaches to use fit comfortably within their current levels of knowledge, skill, and confidence. However, as these continue to increase, and as students' confidence and skill also continue to grow, change may occur more rapidly.

Discussion

Our work with Midland School provides a mini-case study of the educational change process. Educational change has been noted as being a particularly slow process, especially when it comes to adopting new technologies (Cuban, 1986; 1990). The literature suggests that it takes 3-5 years for teachers to become "integrated" technology users (Hadley & Sheingold, 1993). Even with the extra effort and time contributed by Project START, we are not sure that we have expedited this relatively long process. What we seemed to have accomplished, however, was to heighten teachers' awareness of technology use, particularly for those who had shied away previously. By being present in the school, by constantly asking teachers, students, and staff to consider where they were and where they wanted to go with technology, we believe we helped increase the school's awareness of what was happening (and to some extent, what was possible) with technology and thus contributed to the establishment of a technology culture in the school.

Although Midland school did not move as far or as fast as we had hoped, the principal and teachers all perceived that major changes had occurred. The principal stated, "giant strides have been made." The changes that the teachers noted as having occurred at the school level (see p. 15) are cited in the literature as being critical during the early stages of integration: having a plan, initiating use, making use relevant, extending use to new areas, and reconceptualizing use as a tool rather than a reward (Hadley & Sheingold, 1993). Indeed, without these first steps, more innovative and challenging changes are unlikely to occur.

Midland teachers experienced many first-order barriers to computer integration including lack of computers, time, and experience, yet these barriers did not prevent them from becoming "keen on technology." In fact, Midland provides a good example of a how a school with few resources, but with a lot of teacher and student motivation, can jump-start the integration process. During the 1996-97 school year, Midland's culture assumed a strong technology flavor, which we attribute to many interrelated factors: increased student and teacher confidence and skill, use of student trainers, as well as the researchers' presence in the school.

Although teachers were quick to point out existing first-order barriers, they seemed unaware of second-order barriers operating in the process. Yet, in the researchers' view, teachers' existing instructional practices and their beliefs about the role of technology in the curriculum limited the extent to which technology was used to support meaningful learning.

So what happens now at Midland? Even though the literature suggests that technology use can prompt changes in teaching practices and beliefs that might not occur otherwise (Goldberg & Richards, 1995; OTA, 1995), we saw little evidence of these types of changes occurring at Midland. Teachers were not only content with what they had achieved, they were proud--they had made important changes; they had come a long way.

Before we decide how best to assist Midland during the next few years, we need to answer some difficult questions: Have Midland teachers achieved an effective level of technology integration? Should we be content with the gains that have been made? Should/Can we challenge these teachers to search for new uses, new conceptualizations of, and new visions for technology integration? (If so) How can we help teachers move beyond current uses, given their existing teaching practices and expectations for technology?

Although our work with the MCMs has provided Midland with on-going technical support through the use of student helpers, what seems needed now is a greater provision for instructional support. Based on the findings of this study, as well as numerous suggestions in the literature, we believe that this support should be in the form of helping teachers envision the kind of learning experiences they can create for students through technology-based learning activities and then providing the resources (technical, emotional, and instructional) needed to realize this vision. This includes giving teachers the time and support needed to observe exemplary models of classroom technology use, to reflect on and discuss their evolving ideas with mentors and peers, and to collaborate with others (students and teachers) on meaningful tasks as they try out their new ideas about teaching and learning with technology.

Conclusion

"Neither powerful technology nor good ideas are enough to improve education. Success in using computers in education will come only as a result of the intelligent and artful orchestration of many details in the classroom" (Walker, 1996, p. 102), the majority of which are determined by individual classroom teachers. Teachers, not technology, are the key to whether technology will be used appropriately and effectively in classrooms. Thus, efforts to integrate technology must focus on teachers, what they believe comprises good instruction and good learning, and how they put these beliefs into practice.

Rather than address technological or pedagogical needs separately, we propose that technology skills and pedagogical beliefs be developed simultaneously. This might be accomplished by embedding technology training within authentic activities that engage teachers in collaborative problem-solving tasks, relevant to their needs. In this way we can provide teachers with both a vision of what "teaching with technology" looks like, as well as a model of the type of learning experiences we are asking them to create for students.

Regardless of where teachers start in the integration process, whether unfamiliar with technology, student-centered pedagogy, or both, teachers will need to learn new skills related to any or all of the different elements involved in the integration process--technology, instructional design, classroom organization and management, and student assessment, to name a few. Furthermore, most teachers are likely to find themselves having to confront their established beliefs about instruction and their traditional roles as classroom teachers. It is imperative that we help teachers attend to all aspects of technology integration. Anything less, and our efforts are unlikely to result in sustained classroom implementation (David, 1996; Griest, 1996; Pea, 1997).

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Using Technologies And Cooperative Work To Improve Oral, Writing And Thinking Skills: Voices From Experience

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Introduction

Whether we like it or not, the nature of literacy and learning is being redefined by the digital technologies that are quickly becoming a part of the information age in which we live.
(Donald Leu Jr., 1996)

In spite of some disagreeing voices (Oppenheimer, 1997; Postman, 1993) the advances that technology offers to actual society and education are irrefutable (Freitas, 1997; Leu, 1996; Mehlinger, 1995; Negroponte, 1995).

In such a society, where technological, political and social progress narrows more and more the boundaries among people, schools and countries, "information access, problem solving, and communication are essential to success in the information age in which we live". (Leu, 1997, p. 63). Schools play an essential role in preparing students to work and live in this world (Freitas, 1997; Magildson, 1997). Therefore, teachers need to be skilled in the use and application of these technologies in rich communicative contexts: "[T]he role of the teacher will be essential in fostering an environment that creates teaching and learning opportunities and uses the technology to its best advantage" (McHenry, 1997, p.24).

The University of Minho, in Portugal, where we teach, has a great tradition in encouraging and supporting educational technology activities in schools in a collaborative, informal and practice-centered way because we believe, that "there are few topics more important than the role of technology in education" (Hong, 1997, p.188) and we believe also that investigators and teachers can help each other. In fact, as it was previously said by one of us "The full sense of practice just happens whether it has its foundations grounded in theory or it provides a basis for theory building " (Freitas, 1997, p.15). In addition, to the extent these technologies proliferate schools, researchers are under pressure to develop knowledge useful both for teacher training courses, in University, and for practitioners as a way to avoid that "what had started as a subversive instrument of change was neutralized by the system and converted into an instrument of consolidation" (Papert, 1994, p.39).

The fact is that there is a growing body of research focusing on educational technology. However, combining technologies, like Web, videoconference and word processor, with cooperative work to improve language skills, was not done before, at least in Portugal. On the other hand, the present study differs from some previous ones in several ways: a) activities were carried out in authentic classroom context, rather than in laboratory; b) texts written using the word processor were based on real purposes rather than on specially ones written for research; c) data collected include researchers' observations, teachers' commentaries and students' voices, until now often ignored. The analysis was based on grounded theory methodology, one of the most fruitful and used ways of carrying out qualitative research when researchers' main objective is generating theory.

So, in this study, we "does not begin with a theory, then prove it. Rather, one begins with an area of study and what is relevant to that area is allowed to emerge" (Strauss & Corbin, 1990, p. 22).

Theoretical guidelines

Our approach (Freitas, 1997), which is not just ours (see, for instance, Wilson, 1996) is that educational technologies must be used in contexts promoting interaction and allowing access to various information resources and supports. Through wide discussion with peers this information is clarified, allowing a greater understanding of the subjects under study. This approach is consistent with cooperative learning and constructivist approach assumptions.

Among the various approaches to constructivism (Brooks, 1997; Brunning, 1995; Coll, 1996; Carretero, 1997) we adopted the Duffy and Cunningham one as it was referred by Ritchie. They "identified two common characteristics of constructivism environments: a) students learn by actively constructing rather than acquiring knowledge; and, b) the purpose of instruction is to support this construction, rather than the communication of information" (1997, p.27).

By and large, extensive research provided evidence that cooperative learning improves academic achievement, facilitates both cross-ethnic and cross-sex inter-group relationships, and increase self-esteem (Johnson & Johnson, 1981; Johnson, Johnson & Maruyama, 1983; Slavin, 1985; Slavin & Karwait, 1981). A recent study developed by Brush to investigate whether cooperative learning techniques helped to improve success with students in Integrated Learning Systems (ILS) concluded that integrating cooperative learning with ILS-delivered instruction is an effective instructional strategy. Results showed that students working on math activities delivered by an ILS performed better on achievement tests of the content taught when they completed the activities in cooperative pairs than when they worked in activities individually (1997, p. 61).

Other studies in this domain suggest that working together and supporting each other "stimulates initiative, attention to details of performance, and commitment in activity Ö more expert play partner can facilitate the social pretense in low-play peers and not at their own expenses" (Newman, 1997, p.17). Xypas (1997), as others did before (e.g., Smith, Johnson, & Johnson, 1981, 1984), stresses the educational value of conflict that often occurs when students work together. He argues that this conflict impels students to construct more deeply rooted arguments and explanations and gives them the opportunity to assist one another. This peer discussion contributes to cognitive and social gains. Besides, such a supportive learning environment helps to reduce the negative statute of mistakes, that often are a source of anxiety and stress, encouraging students to approach them as the "rolling-carpet" of their cognitive and social growing (Astolfi, 1997).

Creating learning situations that aim at improving linguistic skills and are cognitive and emotionally stimulating for students is, probably, the greatest challenge of language learning teachers. Current language learning perspectives, such as communicative and whole language approaches, suggest the creation of authentic communicative situations in which students a) use language realistically, as a real means of communication in real situations; b) learn and practice language skills - listening, speaking, readifng and writing in a meaningful and integrated way.

As asserted by Landsmann (1995) language learning activities must occur in contexts that promote active learning since students need opportunities to compare and share ideas as a means to reflect about their oral and writing productions and improve them.

The practice of writing skills is also a privileged way to increase thinking skills (Schneuwly, 1988) to the extent that writing makes it possible to reach the most abstract level of language (Vygotsky, 1979, 1993).

Recent approaches to writing suggest that it is a complex and dynamic process consisting of a set of phases (d'Aoust, 1989; Hayes & Flower, 1980). These phases may be focused or not, conscious or unconscious and they are nor independent neither sequential, rather they interact in a recursive process. They include several sub-processes, organized and labeled in several ways by different authors. Summing up, in the writing process we have writing, sharing, revision, correction and evaluation.

Pre-writing activities are supposed to stimulate and shape ideas; writing is the phase in which ideas are materialized in the written word. Sharing allows the writer to revise and improve his text having in mind the feedback given by peers and teacher. In the revision and correction phases, students make further improvements: words, sentences, paragraphs or the whole text. This is the very moment in which the teacher can explore and conduct educational work in relation to language structure and functions. The evaluation, the final feedback, assuming usually the form of assessment, is the final phase of writing

The only ways to increase writing skills are practicing, learning by doing, as suggested by constructivist approaches. Writing tasks for several purposes and in various curricular domains gives students these opportunities to practice writing.

Besides, writing together also gives students an opportunity to improve writing. By constant and constructive feedback provided by peers, by reflecting about their own and other's writing, they can increase writing skills. New writing tools, like word processor, supported by teachers when necessary, increases the group work potential, since they facilitate corrections and improvements in written texts. In addition such a supportive environment develops students self-confidence in expressing themselves, orally and in writing. This is an important first step in improving students' communicative skills.

Therefore, technologies and cooperative learning may contribute to implement learning environments based on constructivist principles that emphasize the central role of communication in language learning.

The Portuguese Curriculum framework

The last curriculum reform (1989) prescribes the adoption of group work to promote and improve cognitive, social and affective skills. Curriculum guidelines also suggest that: a) students must have access to new technologies in various ways namely for the searching, interpreting, organizing and evaluating information; b) technologies must be envisioned as a tool to increase learners development of social and cognitive skills related to several curricular domains. Portuguese syllabi consider that reading and writing instruction must be carried out in several learning environments that stimulate interaction and cooperation between students encouraging successive improvements in written texts as a way to develop writing and thinking skills. Curriculum guidelines also advise that teachers must find learning contexts promoting an integrated development of listen, speaking, reading and writing skills. They also enhance the teacher responsibility in creating active and learner centered activities where processes, rather products, were valued.

These general guidelines follow, generally speaking, theoretical assumptions we have already presented.

Research design

This study was designed and conducted following the qualitative paradigm, which fits well the nature of this study. Following Strauss and Corbin "qualitative methods can be used to uncover and understand what lies behind any phenomenon about which little is yet know ... and can give the intricate details of phenomena that are difficult to convey with quantitative methods" (p.19).

We combined several approaches, following a trend of utilizing mixed-methods (Creswell, 1994; Greene, Caracelli, & Graham, 1989; Guba, 1992). Although we may consider our research as ethnographic, the *grounded theory* (Glaser & Strauss, 1967; Strauss, 1995; Strauss & Corbin, 1990) was the main approach in this study.

Intervention Design

We have selected teachers who usually create learning environment that follow the orientations of theoretical framework of this study, and routinely use educational technology in their classrooms for several purposes.

The research team was directly involved with school teachers. Nevertheless, we both consider that teachers have a central role and the main responsibility in designing learning environments where educational technologies are integrated. So, our role as researchers is not to orient as experts, but to facilitate and support teachers work in this domain.

The study was conducted during two school years in four elementary (grades one and two) and secondary schools, involving just a classroom and a teacher each one. It included mainly writing activities with the word processor but also videoconference and WWW for pre-writing activities and other purposes.

Videoconference

Five videoconferences were carried out: two for research team and school teachers to plan the students' activities, testing the connections and other details; three integrated in pre-writing students' activities. All the videoconferences were implemented between University of Minho, Portugal, and the University of Exeter, U.K. where a colleague of us, who was taking his PhD there, helped to set up the sessions.

Secondary students came from a professional course in media communication, so their aim was to know, in a hands-on way, how videoconference system works and its role in actual media communication field. From Exeter, our colleague demonstrated the functioning of videoconference system and other multimedia tools and services. They also discussed implications of videoconference in social, personal and educative domains.

Videoconference sessions for elementary students followed a different approach. Students developed project work in class comparing some aspects of society and culture in both countries to exchange ideas about that. As their colleagues did, they had previously prepared a set of topics, questions and other materials, like pictures, cards and written slogans, to support the presentation of their project work. Colleagues who did not participate in videoconference engaged in other kind of activities integrated in their global project work.

WWW

As in videoconference, the intention of secondary students was to know how Web works rather than using it as a way of gathering specific information. The aim of preparatory students was to obtain information related to their specific subject of project work they usually do. The class was split in groups. Each group participated in three 3 hour sessions.

In the first session, and after an initial period of free web browsing, students conducted web searches according to their interests. They had previously chosen a number of topics and key words in English, which were used to search for information. They were allowed to choose navigation itineraries. In order to prepare the second session, a number of selected web sites were bookmarked. The information retrieved was printed out and studied during the week as homework and in class. With teacher support, topics for further exploration in the second session were selected.

In the second session the collection of information was completed. A vast amount of topics followed by an abstract, in English, resulted from this process. Students then analyzed this information: they identified the issues emerging and selected topics, which were translated into Portuguese. After that, they discussed and structured their ideas and outlined a plan of a text to be written later. The role of the teacher was fundamental in this phase, in order to help students to select, organize and structure the available information. Finally, students wrote texts in a collaborative way and using word processor.

The third session occurred the next school year and was similar to the first ones, as only the project subjects changed.

Word processor

In students writing we considered pre-writing, writing and revision-correction phases. Although videoconference and web activities had other aims, they were also considered as pre-writing activities. They intentionally included different curricular subjects as a way to promote an interdisciplinary approach. As referred by Kaufman (1994) it is absurd that teachers promote writing tasks only as a means to evaluate students' ability to write. Promoting writing activities in several curricular domains was a natural way to practice and improve writing skills.

Written activities with word processor were carried out at schools in various contexts, including language classes. Students were randomly organized in groups. They wrote as they usually did. No suggestions about writing process were given to students. Texts produced had a real audience because they were integrated in several communicative circuits, like school newspapers, project work and exhibitions.

Data collection

Data were collected by different methods and from different sources: classroom observation, students' interviews and teacher description, evaluation and comments to the activities carried out.

Data triangulation increased the validity of the study (Cohen & Manion, 11989; Denzin, 1978; Foster, 1996; Marshall & Rossman, 1989; Maxwell, 1996; Scott, 1996) and help to grasp the complexity of the research area.

The main data source were a series of videotapes on videoconference, WWW and word processor activities above presented. There was a total of 40 hours of observation. All videotapes were transcribed.

We interviewed students informally. Students had to respond to both general and specific questions about activities they carried out with technologies. We also presented some open-ended questions designed to give students the opportunity to share their perceptions and approaches and to explore their thinking not only about task carried out but also about future work. All interviews were videotaped and transcribed.

Teachers were also asked to give their opinions about work carried out with technologies by means of informal talks at the end of each session and by written commentaries.

Data analysis

The process of data analysis is still in course and it began during data collection itself, where some general patterns began to emerge. In the next step, all observations and interviews were transcribed as completely and literally as possible with some essential prosodic features.

These transcripts are being analyzed using the grounded theory methods (Glaser & Strauss, 1967; Strauss, 1995; Strauss & Corbin, 1990). Theory will be inductively built using well-established steps. The first procedure of *open coding* is breaking down and conceptualizing data. The patterns that emerged were then categorized and potential labels are being explored.

The next analytic procedure, *axial coding*, involves linking subcategories to a category by tracing relations between them in terms of *causal conditions, phenomena studied, context, intervening conditions, action/interaction strategies*, and *consequences*. This *paradigm model* shows interdependency of categories

Selective coding procedures shall lead us to the conceptualization of the central phenomenon, the *core category*, around which all the other categories are integrated. This is the core message of the research.

These themes and emerging trends are presented as proposition statements.

As a matter of fact, many authors (Lee & Fieldind, referred by Prothero, 1996; Miles & Huberman, 1994;) suggest that qualitative researchers can not ignore computer software for qualitative data analysis. According to Richard and Richard (cited by Prothero, 1996) "the computer allows researchers to explore and interrogate emerging patterns, to keep asking questions and drawing together different levels, contexts, relationships to test their significance and to chase ideas about the ways they pattern data".

Our choice for qualitative data analysis software was Nud*ist (Non-numerical Unstructured Data Indexing, Searching and Theorizing). This is a multi-functional software system that helps researcher to handle non-numerical unstructured data by indexing searching and theorizing.

Up to the present moment, we have identified and broadly described the key features of some emergent patterns. In this first step of data analysis we seek to identify emergent "voices" still without their articulation and integration. According to the title of this paper, we just report here these "voices from experience" in a preliminary framework of research findings.

Research findings and discussion

Findings, although provisory, as we have clearly stated, allow us to enhance some of the key emergent voices and to realize that, often, they tune with voices from other research studies.

1. Videoconference promotes the connection between people at various levels and in several ways.

The *cyberspace* "that invisible arena where humans are connected by electronic technology, not by geographic proximity" (Anderson-Inman, 1996, p. 134) allows a climate very similar to face-to-face communication which creates a real need to express their ideas and to listen and understand colleagues in a really interactive way.

Students from different places and with different backgrounds and capabilities work together discussing personal ideas and sharing information about different curricular subjects in a vivacious and authentic interpersonal communication. This collaboration not only allows different perspectives in treating subjects, but also increases students' oral skills. Students must think and react rapidly and this spontaneity added to peer support stimulates some interventions of less skilled students that usually do not take this risk. In fact we noticed remarkable interventions and even "flash of eloquence" of special needs students who usually were silent in other classroom activities. It seems that colleagues support and communication atmosphere itself increased their self-confidence leading them to overcome a bit their affective and linguistic difficulties.

In such an authentic and dynamic situation, where students must find quickly and efficiently what they need, it was easily accepted both by teachers and by students that speech was not always correct. However, from time to time, they asked for help, reformulated speech and they were spontaneously corrected and supported by colleagues which reveals their interest in improving their language skills. Giving immediate, contextual and friendly feedback seems to be a good way to articulate theory and practice in language learning.

We noticed that, in spite of students' enthusiasm and happiness to "meet in virtual classrooms, collaborating and co-constructing their educational experience" (Anderson-Inman, 1996, p. 137), their best pleasure will be to meet personally their new British friends. It was clear that videoconference does not replace or diminish face-to-face relationships that are essential in education as in life; rather it creates in students the need to know better people they interacted with.

One of the major challenges in foreign language learning is to create environments where students are so immersed in target language contexts, that they really need to communicate with others. Such an authentic environment encourages the discovery of language as tool for real communication purposes. Evidence we have collected suggest that videoconference offers a great opportunity for it.

2. The way the information is provided on the Web, following a hypermedia structure but with a dominant amount of text provides opportunities for the development of written comprehension. We noticed that students read

attentively in order to make further choices. This hypertext/hypermedia model also required the development of new reading techniques: due to the amount of information they are faced with, students quickly discover reading must be selective and oriented to their interests. So, they are forced to abandon the sequential reading way they are used to and adopt pro-active, flexible and focused reading and selection strategies.

Web based activities provide an opportunity to improve linguistic skills both in Portuguese and in English because students constantly translate between these two languages either to input search queries or to understand search results.

Gathering information in Web also promotes the development of the thinking skills required by information search, selection, analysis, evaluation and synthesis - these abilities are becoming increasingly important nowadays. Students outlined, discussed and refined search strategies seeking for more precision. Given the quantity and variety of information collected, students gathered a wide variety of perspectives and ideas with a range of levels of complexity. According to Ryder & Graves the "Information age literacy requires learners who are proficient in focusing attention, attending to an accessible and dynamic medium, and thinking critically" (1997, p. 251). Then, in a synthesis process, students compared, contrasted and structured the information under a coherent framework: "Information literacy requires learners to obtain and derive meaning from diverse and extensive sources of information and to regulate their own thinking in pursuit of a level of understanding that goes well beyond memorizing the details of a classroom textbook" (Ryder & Graves, 1997, p 252). Carrying out these tasks requires skills classified by Bloom at the top of the hierarchy of cognitive objectives.

Evaluating validity of the information available in web, on one hand, and selecting the most important topics, on the other hand, are probably the biggest and more complex challenge both for teachers and for students. In fact, as stressed by Roberts "students need to evaluate the content of what they find on-line, just as they do with traditional sources. Evaluating sources and comparing facts and opinions are essential activities when exploring on-line databases". But, the same authors remark, "How can children learn to evaluate the information they obtain?" (1990, p.79).

Since students worked in groups, they had the opportunity to share ideas, achievements and difficulties, both in content domains, searching features and linguistic area. This kind of task in such a context provides support, encouragement, and, as asserted by Oliver (1997), the development of students' social and thinking skills.

According to Roberts "just as the world is exploding with new information, it is also becoming increasingly complex. Today, answering questions, solving problems, and exploring new ideas requires that people work together.... This collaboration requires communication, communication with people in next office, in another city, or around the world" (1990, p.3). Once again, this emphasis in collaboration and communication demonstrates how useful are Web based activities for the present and future life of students.

With Ryder and Graves we consider that "[t]here is no doubt that if students are to be effective in their ability to engage in the higher level thinking tasks associated with information literacy, they will need to regularly engage in these tasks and acquire strategies tailored to the diverse and ever-changing resources on the Internet" (1997, p .253). Web activities in cooperative learning environments are, we believe, a good step in this direction.

3. Writing activities in several curricular domains are a good way to improve writing skills, and provide students with an opportunity to approach language not only as an object of study in itself but as a learning tool in other curricular domains. In addition, the fact that texts were written for a real purpose and had a real audience also increases students interest in the task.

Videoconference and Web based activities are good pre-writing strategies not only because of students' gains in terms of language and curricular content we referred above, but also as a way to enhance the need for selection and organization of ideas, before writing. In fact, information gathered was usually so copious, rich and disperse, that they really fell the need to organize it.

In such a context, where content features were previously prepared, and peer interaction encouraged, word processor increases students interest in the writing task and stimulates constantly improvement of their text.

Experience clearly shows and research evidence suggests (Underwood, 1991) that the use of traditional writing tools makes it difficult to improve written texts, since it is necessary to repeat the writing process from start.

It is important that students do not force themselves to be correct at their first attempt. The process of transforming ideas in writing is hard owing to the various demands that operate simultaneously: the sequence of ideas, the vocabulary, the orthography, the syntax, the logical sequence of the text. We can think of few things at a time, so attention to all these aspects overloads short term memory and they tend to give priority to formal aspects rather than to more cognitive challenging requirements. Since word processor allows easy modifications in a drafted text, students can pay attention to each aspect at a time: after expressing ideas, they debate until they arrive to the best form.

It seems that because it is so easy to correct, students are encouraged to make constant improvements in a first and free draft: they write, they modify as much as they need, often with colleagues' support, and the text remains clean.

It was observed that corrections students did within or after text production were dominated by spelling, punctuation, accentuation and vocabulary. It goes without saying that we are not surprised with their intervention at such a low level: it is the style of correction teachers usually uses! Obviously, we cannot expect students, spontaneously, do more. Technology by itself has had little impact on student achievement (Duffield, 1997).

But, if the teacher follows the writing process, going near the students that need assistance, he/she can understand the source of students' doubts and mistakes and, in consequence, he can support them in their attempts of correction. Focusing these real, specific and in context problems is a great way to practice grammar not as an end in itself but as a means of improving written communication. By doing so, and according to MacEnery, " [g]rammar learning means not studying and memorizing prescribed rules about grammar, but acquiring skills and insight into the ways in which grammar, that is to say the forms of words and the sequences in which they appear in sentences, paragraphs and texts, communicates meaning" (1997, p.9)

In addition to word processor performances, it seems that the motivation to discuss and make suggestions to improve early versions of the text was also enhanced by the cooperative nature of the task as well as the common use of the computer screen, the "virtual paper" (SablÈ and Bouyssou, 1995). As a consequence of group work in students tend to think aloud, expressing their own ideas and doubts, asking colleagues for what they do not understand. Each one made his contribution according to his own capacities, so text results from the combined effort of them all.

According to Dale (referred by Sanacore, 1997) "the real value of co-authoring groups is not the collaborative product but rather the peer interaction. As the students talk about their writings, they may discover novel ways of thinking about writing; however, this valuable growth may or may not be revealed in the written product". In fact, we are not sure that texts produced in word processor were much better than previous ones, but data collected demonstrated that, together, word processor in cooperative learning activities and teacher support, can really contribute to improve written skills. In addition, such an environment of speaking-reading-writing promotes a comprehensive development of all these skills.

4. Cooperative learning environments not only reinforce students' spontaneous disposition to share and discuss ideas but also encourage the less skilled ones to participate in task, in any way, and support their attempts. Naturally, there also occur some disagreements between students and this promotes rich and usually useful discussion. Through this dialog, they learn to explain and to specify their ideas and also how to understand colleagues' ideas and how to ask for more explanations. According to Bearison (referred by King) "resolving such cognitive conflicts should create some change in the learner's cognitive structures or processes. The aggregate of these changes in group member's cognition may promote the group's success in solving the problem" (1989, p.11).

Learning from one another, as it occurs in cooperative work, stimulates students engagement in their learning process thus increasing, as is pointed out by current constructivist learning theories, their responsibility in constructing their own knowledge. This is an important step in preparing students for the challenges of their tomorrow, since, more and more, one constantly needs to update knowledge and abilities in several domains (Leu, 1996).

Constructivist environments do not reduce teachers responsibilities in learning process, rather they require "a fundamental change in the way teachers approach instruction . . . [T]he highest compliment a teacher can receive from a learner is *you made this so easy that I was able to learn it by myself*" (Mehlinger, 1995, pp. 76-77).

5. There are no easy neither definitive answers to integrating technology into educational learning contexts. Yet, as Brownsuggests, "it takes about 30 years to blend a new idea into daily practice. In teaching new ideas and teaching methods cycle in and out favor more frequently. Integrating them solidly into practice, however, may still take several years" (1997, p. 17). Because we believe that for teachers good experiences are more motivating than good theories we consider that research must be rooted in concrete classroom activities.

The purpose of this study was to explore the contribution of educational technologies and cooperative work to develop linguistic and thinking skills. As the major authors of grounded theory suggest, research should be designed as a continually evolutionary process. We took a first step. Further data analysis will give a deeper understanding of the problem bearing in mind that "in postmodern realm we cannot claim to know anything completely" (Addison, 1997, p. 107).

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Essential Elements for Developing Effective Instruction in Any Setting

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Introduction

While there are numerous books, journal articles, and models of instructional design, few of these resources discuss the impact that environmental forces have upon decisions relating to instruction and training. There are forces within and outside of educational institutions, businesses, and agencies that play a significant role in decisions of whether or not to use instruction or training. Issues relating to government legislation, insufficient resources, incompatibility with societal goals, and lack of strong support can cause instruction or training to be ineffective. The importance and high cost of training and instruction point to a need for instructional designers to make certain that the end result is effective.

In this paper we offer a definition for the word *effective* and then discuss implications of research on the environment in relation to designing effective instruction. Similarities and differences involved in designing effective instruction are presented across four different contexts: K-12, Higher Education, Human Services, and Corporate. We posit that the primary reason instruction and training fail to achieve intended goal(s) is due to instructional designers' tendency to overlook or underestimate environmental issues. With this in mind, we suggest that environmental issues be thoroughly addressed before instructional designers proceed with the design process. Our views and model for designing effective instruction have been formed as a result of our experiences and from an examination of research and theory from a variety of fields.

Definition for Effective

The word *effective* has many meanings. Capable of producing a desired result or effect is one of its meanings. Similar definitions include "ready for service" and "prepared for use or action". We all know of people, ideas, and technological innovations that have the potential to accomplish a desired effect or result, but never advance past a state of readiness. An essential part of being effective is having the potential or the ability to achieve. However, this does not encompass the entire sense of the word.

Another meaning associated with the word *effective* is the actual production of an intended or desired outcome or result. Words related to this meaning include operative, working, and active. Emphasis in this meaning is on actual use for achieving results whereas emphasis in the previous meaning is on potential ability of someone or something to produce intended outcomes.

We believe that the definition for effective should include both potential and production. The definition, "producing or capable of producing a desired effect," found in both Webster's College Dictionary (1990) and The American Heritage Dictionary (1983) implies that a separation of two meanings is acceptable. Ability to perform without achieving the expected results is an ineffective use of time, talent, and other resources. Truly effective individuals, ideas, and innovations are not only capable of, but actually produce an intended or desired effect.

Application of Effectiveness to Instructional Design

When a request for training or instruction is received, most instructional designers conduct a needs assessment to examine gaps between current and desired human performance and gather information that assists with problem solution. If human performance deficiencies are identified, designers typically begin work to determine tasks and corresponding knowledge, skills, and attitudes to be included in the instruction or training. In essence, they jump right into planning a solution before considering many of the essential elements required to develop instruction that is effective.

Instructional design models, textbooks, and courses focus on the procedures and techniques for developing quality instruction, curriculum, and training. Unfortunately, this becomes the sole goal for most novice and even some experienced instructional designers. No matter how well designed an instructional product might be, it is ineffective if it is never used.

Effective instruction and training should be the goal for all instructional designers. If our argument for an all-encompassing definition for effective has been convincing, then it should be clear that a well designed instructional product alone does not guarantee effectiveness. In addition to being well designed, effective training or instruction must be "operative", "active", or "working" to eliminate or at least reduce human deficiency problems. Based on our knowledge and experience, instructional designers are not adequately prepared with strategies to help ensure that the latter occurs. Educational institutions, human services organizations, and businesses are more likely to use instruction or training if certain issues discussed later in this paper are addressed.

Role of the Stakeholders and Setting in Instructional Design

Creating effective instruction or training requires instructional designers to perform tasks beyond the design of quality products. Almost all instructional and training products, from the most simple to the most complex, are designed to be used in a particular setting or environment. Therefore, instructional products must be appropriate for the setting in which they will be used. In addition, the implementation of instructional and training products is impacted by the stakeholders, people who can affect or are affected by its implementation. Many instructional designers underestimate the influence of stakeholders and the setting.

Examination of the role that stakeholders and the setting have in the instructional design process commonly begins and ends during the needs assessment. The possible causes of deficient performance can be attributed to lack of knowledge/skills, lack of motivation/incentives or environmental barriers (Harless, 1978; Rossett, 1991). To determine possible causes or contributing factors, the setting is examined for insufficient resources, deficient equipment, deficient process, conflicting demands/standards, and other flaws. Also stakeholders are consulted and observed to gather information concerning performance problems. If the setting is in order, instructional technologists rule it out as a possible cause of deficient performance. If the setting is flawed in some way, they make recommendations to fix it. In either case, most instructional technologists do not think further about the role that the stakeholders or the setting play in decisions whether or not to use instruction or training.

Organizational change theory has long noted the impact that events, resources, various people, and their power bases can have on whether an idea, product, or technological innovation is used in a setting. Many journal articles and books providing practical suggestions to help bring about change in elementary and secondary schools, colleges and universities or businesses can be found in the literature (Berman & McLaughlin, 1978; Fullan, 1982; Havelock, 1973; Havelock & Huberman, 1978; Mayhew, 1976; Rogers, 1995; Zaltman, Duncan, & Holbeck, 1973; Zaltman, Florio, & Sikorski, 1977). These publications offer good suggestions usually in the form of recommendations and guidelines, but the advice is not specific to instructional design.

Drawing on organizational change theory Diamond (1989) emphasized the importance of considering institutional priorities, faculty support, and other environmental issues in his development model. When designing or redesigning a course or curriculum Diamond (1989) suggests that instructional designers do the following:

> Before a project is begun, a number of factors must be consider: (1) how important the project is to the academic department, school, or college, and when appropriate, even to the institution, (2) how the project will be received by others, (3) whether the necessary support is available, and (4) if the required faculty commitment will be made (p. 21).

Although the Diamond model was developed for higher education, similar environmental impacts affect instruction in other settings. Instructional designers, regardless of the setting, should understand what environmental elements are likely to impact training or instruction and how they will affect it. This requirement for an understanding of environmental issues goes beyond the concepts and practices that are traditionally taught in the instructional design field.

Model for Creating Effective Instruction

Our experiences indicate that while well designed instructional products are an essential factor, usage is largely dependent upon the appropriateness of the instruction for the respective stakeholders and setting. Therefore, instructional designers, regardless of the setting, should understand and address elements that are likely to impact training or instruction. When issues relating to the setting and stakeholders are left unaddressed, the result may be losses of time, personnel, money, and other resources. Neither schools, universities, businesses, nor human service agencies can afford such losses.

A model of **E =PxSxS** will be used to frame the discussion about developing effective instruction or training (see Figure 1). Respectively, the letters stand for effective, product, stakeholders, and setting. The multiplication symbol is used between letters rather than an addition symbol because if any factor is missing the end product will be zero or ineffective. This model is generic in the sense that instructional technologists in any setting can use it. In addition, novice instructional technologists will find the model easy to comprehend, while most experienced designers will appreciate having guidelines and suggestions for addressing stakeholder and setting issues.

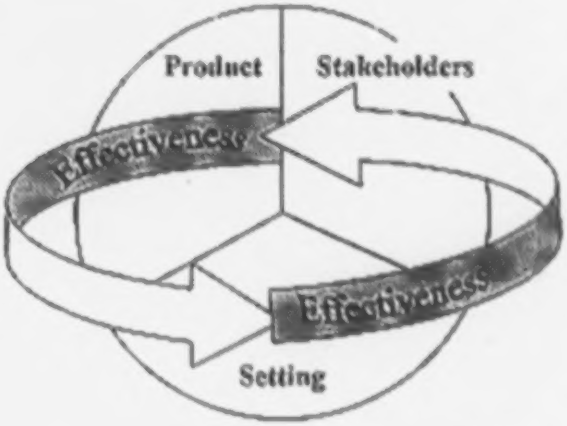

Figure 1. E=PxSxS: A Model for Designing Effective Instruction or Training

Product

With the rise of "quality" management programs, many organizations, including educational ones, have become more concerned about improving the quality of products at all levels (Rossett and Krumdieck, 1992). "Quality Products" in this sense means "fitness for use" or "conforming to specifications". Designers satisfy this standard by demonstrating credibility, striving for the "ideal" instruction, producing the promised deliverables, delivering instruction on time and within budget, and conducting formative and summative evaluations. The design and development of quality instructional products is the primary goal of many designers. Therefore, designers are well aware of the standards for achieving quality products illustrated in design models and discussed in texts and articles.

Suggested Questions Pertaining to Product

- Are the deliverables (products and/or services) appropriate and sufficient for addressing the deficiency problem?
- Do you or other team members have the necessary skills to design and develop the instruction or training?
- Has the developed instruction or training been field tested to see if it actually eliminates human performance deficiencies?

Stakeholders

Achieving commitment and support from stakeholders gets less consideration in the realm of instructional design than does the design and development of quality products. Typically, the designer gets a contract and jumps into designing instruction. Time spent on gaining the support of others within the institution or business is often forgotten until it becomes a problem. If commitment and support issues are dealt with early on it is believed that success and effectiveness will increase. Most instructional designers can relay horror stories of working hard on a project requested by an organization leader or decision maker only to find that half way through the project a powerful mid-level opinion leader or group of opinion leaders are not in support or agreement on the project. Part of addressing acceptance issues is paying attention to the top decision-makers and opinion leaders within the

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institution. Winning the support of these people can mean the difference between a product that sits in a binder on a shelf and one that is torn and tattered from use. The designer should also collaborate with others, especially SME's (subject matter experts) and the intended recipients of the training. The input that SME's and recipients can provide will smooth the road toward implementation.

Suggested Questions Pertaining to Stakeholders

- Has the need and logic of the training or instruction been communicated to the stakeholders (people who can affect or will be affected by its implementation?)
- Is stakeholder participation sought, welcomed, and their advice used?
- Do key decision-makers support the instruction or training?
- Do the institution's opinion leaders support the instruction or training?
- Is union support necessary for the training or instruction to be conducted, and if so has it been received?

Setting

Analysis of the setting for which the instruction or training is being designed is often under emphasized. Setting refers to the physical environment, the culture, and the resources of the institution or organization. Setting can also involve such things as the technological, social, political, and economic conditions or trends.

Suggested Questions Pertaining to the Setting

- Do you have an understanding of the culture that guides the school, university, business, or other institution in which the instruction or training is intended?
- Can resources required for the training or instruction be acquired and/or developed?
- Are facilities, equipment, and other items necessary to conduct the training or instruction available when needed?
- Is the instruction or training aligned with technological, organizational, and societal trends?

The suggested questions are fairly comprehensive but may need to be modified to fit your particular situation. Based on our own experiences and interviews with colleagues we propose the following generalizations with regards to the development of quality products, identification of stakeholders, and issues involving the setting for the contexts of K-12, Higher Education, Corporate, and Human Services. These suggestions are based on preliminary discussions and will be backed up by more intensive research in the near future.

Our experience and investigation has led us to propose that in K-12 contexts the perception of quality concerning products hinges on relevance and applicability of the instruction or training in the classroom. When working in the K-12 context it is important to involve teachers, students, principals, and superintendents. Typically, K-12 teachers have to feel a sense of ownership before they will implement new lessons or other types of instruction in the classroom. To achieve this, their involvement is necessary at all levels of the design and development process. Finally, the K-12 setting poses some significant time constraints as well as possible physical environment issues, especially in elementary schools. If instructional designers are not sensitive to limited budgets and teachers' scheduling issues, their instruction will be ineffective because it will not be used. In Higher Education contexts we found that the perception of a quality product is often tied to the credentials of the instructional technology professionals and theoretical grounding. Some of the stakeholders who are important to involve include deans, department chairs, professors and students. It is also important to understand the culture of the environment, how people work together, and students' learning styles and preferences. Human Services agencies tend to equate the quality of a product with the emotional reaction of those involved as well as the relevance of the product to the needs of the agency. Diverse perspectives must be sought from staff and clients in order for instruction or training to be effective in this setting. Finally, the economic constraints and culture of the setting are very important to the success of training or instruction in Human Services institutions. The last context discussed in this concept paper is Corporate. Corporate clients usually need to see a change in attitudes, skills, or behavior to consider training or instruction effective. Many corporate clients take quality a step further and demand measurable results tied to the bottom line. Top management, unions representatives (if applicable), and the individuals affected by the training or instruction must be involved in the design and development processes. Finally, the culture of the corporate setting is extremely important. Instructional technology professionals must investigate the culture and economics of the setting if they are going to be successful.

Conclusion

Most instructional designers faced issues of product quality, stakeholder acceptance, and appropriateness for the setting. All three must be considered in appropriate detail if designers expect to be effective. The first step in producing effectively designed instruction is to follow a systematic design process such as those suggested by Gagné, Briggs, and Wager (1992) or Dick and Carey (1990). In addition to these systematic processes, designers should add to their repertoire of activities a more intense consideration of the stakeholders and setting for which the instructional is being designed. As educational institutions, businesses, and other organizations face increasing pressures to be more accountable for costs, instruction or training that fails to achieve desired results is looked upon with greater disfavor. A focus on quality along with stakeholders and setting issues will improve the probability of instructional designers' success with creating effective training or instruction.

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Improving Mathematics Instruction Using Technology: A Vygotskian Perspective

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Introduction

The need for reform in mathematics education is well documented (International Association for the Evaluation of Educational Achievement, 1996; National Commission on Excellence in Education, 1983; National Council of Teachers of Mathematics, 1989, 1991, 1995). To address this need, the National Council of Teachers of Mathematics (NCTM), in concert with other professional organizations, developed the NCTM Standards (National Council of Teachers of Mathematics, 1989, 1991,1995). These Standards redefined the parameters of mathematical literacy, the scope of mathematics instruction, and the areas of content emphasis in the K-12 mathematics curriculum. The implications of these changes for the classroom teacher are considerable; compliance with the Standards may require the classroom teacher to reevaluate his or her role and the roles of his or her students in the teaching/learning process. Modifying classroom roles and monitoring the resulting changes may prove to be a formidable undertaking.

The Professional Standards for Teaching Mathematics (National Council of Teachers of Mathematics, 1991) identified five major pedagogical shifts that are necessary to achieve the NCTM goals in today's mathematics classroom. These shifts will directly affect not only the classroom environment, but also the roles of students and teachers in the learning process. The 1991 Standards proposed:

- a shift toward classrooms as mathematical communities – away from classrooms as simply a collection of individuals;
- a shift toward logic and mathematical evidence as verification – away from the teacher as the sole authority for right answers;
- a shift toward mathematical reasoning – away from merely memorizing procedures;
- a shift toward conjecturing and problem solving – away from an emphasis on mechanistic answer-finding;
- a shift toward connecting mathematics, its ideas, and its applications – away from treating mathematics as a body of isolated concepts and procedures. (p.3)

The Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics, 1989) pointed out that advances in technology have extended the boundaries of mathematics and underscored the importance of the integration of technology in the mathematics curriculum. In a summary of the Third International Mathematics and Science Survey, Beaton, Mullis, Martin, Gonzalez, Kelly, and Smith (1996) asserted that technology is a key factor in determining the economic health of a country. They also pointed out that the overriding presence of technology makes new demands on educational communities to prepare students with high levels of technical competence and flexible thinking. For these reasons the International Association for Evaluation of Educational Achievement (IEA) (1996) recommended appropriate integration of technology in the mathematics curriculum. The Board of Governors of the Mathematical Association of America (MAA) maintained that computing has a profound and permanent impact on the practice of mathematics at all levels (Steen, 1992). The MAA recommended that technology be incorporated into the mathematics curriculum in a way that permits students to connect mathematics with diverse fields and applications, and to put mathematical ideas into action.

The NCTM Standards do not imply that the use of technology guarantees mathematical literacy, or that the use of calculators eliminates the need for students to learn algorithms. Rather, the standards indicate how technology can be used to facilitate the learning process and to emphasize the fundamental mathematics students will need.

The NCTM Curriculum and Evaluation Standards stated three overreaching goals: (a) students should become mathematical problem solvers; (b) students should learn to communicate mathematically; and (c) students should learn to reason mathematically (pp. 5-6). These goals assume active student learning, and emphasize the necessity for students to develop an understanding of mathematical models, structures, and simulations so that they may apply their mathematical knowledge flexibly across situations and disciplines. In this context, mathematics instruction becomes process-driven rather than product-driven, and in many respects becomes a collaborative endeavor.

A report by the Council of Chief State School Officers (CCSSO) on state-by-state trends in teaching practices and content emphases in instruction (Blank, & Gruebel, 1995) presented data representing the extent to which mathematics classes in grades 4 and 8 included weekly instructional practices that are consistent with the NCTM standards. The four types of instructional practices were: (a) work in small groups, (b) write reports or do mathematics projects, (c) use manipulative objects, and (d) use calculators in class. The CCSSO survey found that on a weekly basis 65% of the mathematics classes nationally have students work in small groups, 1% of the classes include math projects and/or reports, 46% employ math manipulatives with instruction, and 18% use calculators. These findings suggest that change is still needed in many United States classrooms in order for mathematics instruction to comply with the NCTM standards.

The Professional Standards for Teaching Mathematics and the Assessment Standards for School Mathematics (National Council of Teachers of Mathematics, 1995) recognized that teachers are primary figures in changing the ways in which mathematics is taught and assessed in schools, and that technology is an important component of that change. It becomes apparent that teachers and other educators must bear the major responsibility for realizing the NCTM Standards in practice.

Strategies and programs for improving mathematics instruction should be derived from sound educational theory. The sociocultural learning theories of L. S. Vygotsky (1986) may offer guidance in developing technology-based mathematics curriculum materials consonant with the NCTM goals and objectives. Vygotsky's theories, especially when they are applied to the use of current and emerging technologies, have the potential to help classroom teachers narrow the gap between current practices and the vision of mathematics education represented in the NCTM Standards. Vygotsky's theories appear particularly useful for defining and guiding the changing roles of the teacher and students.

Vygotsky's Theories of Sociocultural Learning

Vygotsky's sociocultural theory of mind serves as a middle ground between formalism and constructivism (Kozulin, 1990; Moll, 1990; Vygotsky, 1986; Wertsch, 1985;). Concept formation, according to Vygotsky's theory, is a dynamic interactive action between the concrete and the abstract that does not require the child to reinvent information (as does constructivism), nor does it expect the child to conceptualize abstractions without having first engaged in concrete activities that support the formation of mental models. Vygotskian theory incorporates several key ideas relative to levels and types of concept formation, the role of collaborative interchange in concept development, and instructional configurations that guide and promote concept development.

Language

Language, and its relationship to thinking, is at the foundation of Vygotsky's sociocultural theories; he contended that language is an indispensable requisite for all intellectual growth. Vygotsky (1986) contended that a concept is not "...an isolated, ossified, changeless formation but an active part of the intellectual process, constantly engaged in serving communication, understanding, and problem-solving." (p.98) He argued that the language of adults and others which surrounds the child is a major factor in the child's cultural and social environment, and that this language influences the content of the child's thoughts as well as how the child thinks. Vygotsky did not isolate verbal interchanges with adults as a separate component in the process of a child's concept formation, but rather stressed the essential interrelationship between sensory material and words as mutual components of a child's concept development.

The child and the adult may share many word meanings, but Vygotsky (1986) cautioned against using this as evidence that the mental operations of the child and adult are one and the same. He maintained that it is through verbal interactions with adults and sensory interaction with their culture that children negotiate meaning and form concepts. Vygotsky viewed conceptual thinking as being purposeful in that it arose in answer to a problem:

> Memorizing words and connecting them with objects does not in itself lead to concept formation; for the process to begin a problem must arise that cannot be solved otherwise than through the formation of new concepts. (p. 100)

According to Vygotsky, attainment of real concepts is impossible without words (Vygotsky, 1986; Vygotsky & Luria, 1993). Therefore, he considered the central moment in concept formation to be the point at which the child is able to use words as functional tools. He considered words to be the tools or means that direct mental operations and focus their course toward the solution of a problem.

Spontaneous and Scientific Concepts

Vygotsky recognized the need to connect formal concepts learned in school with children's understanding that resulted from their everyday experiences (Davydov, 1990; Ratner, 1991; Schmittau, 1993). The crux of the Vygotskian approach to instruction lies in the differentiation Vygotsky made between spontaneous and scientific concepts. Spontaneous concepts are formed by the child through everyday exposure to the cultural environment; they are unsystematic and highly contextualized. Scientific concepts are mediated through formal instruction; are characterized by hierarchical, logical organization; and typically are derived from the highly structured activity of classroom instruction. Spontaneous and scientific concepts are characteristically different, yet they are not independent of each other.

While Vygotsky (1986) asserted that scientific and spontaneous concepts develop in reverse directions, he maintained that they are closely related, with each supporting the formation of the other. He perceived spontaneous concepts as bottom-up constructs that must be sufficiently developed before the child is able to absorb a related scientific concept. In Vygotsky's words:

> In working its slow way upward, an everyday concept clears a path for the scientific concept and its downward development. It creates a series of structures necessary for the evolution of a concept's more primitive elementary aspects, which give it body and vitality. Scientific concepts, in turn, supply structures for the upward development of the child's spontaneous concepts toward consciousness and deliberate use. (p.194)

Zone of Proximal Development

Vygotsky (1986) argued against traditional cognitivist theory, which suggests that a child's developmental level should lead instruction. He contended that the child's current developmental level should be viewed as a starting point rather than as an ending point; a point at which instruction leads rather than follows development. Vygotsky proposed that the appropriate level of instruction lies between a child's actual mental age (i.e., his or her level of independent functioning) and the level of problem solving that the child is able to reach with assistance.

Vygotsky labeled this domain the zone of proximal development (ZPD). With adult support, the child is able to accomplish more than he or she is able to accomplish independently. The child's state of development is the limiting factor in this process. Mediation leads a child through his ZPD via verbal communication and collaborative interchange with an adult or more competent peer. As the child becomes more capable of independent thinking, the child's state of development rises and mediation can reach toward a higher instructional level, thus leading development.

The child's movement through the ZPD is characterized by concept development and intellectual movement which are subject to the child's own developmental laws. Movement through the ZPD involves intelligent, conscious imitation, which requires that the child first understand the field structure and relationships between objects. This conscious imitation should not be confused with automatic imitative behavior that shows no signs of conscious understanding.

Vygotsky's theories and the tenets of the NCTM standards appear to have many areas of commonality. Both imply multidimensional thinking rather than one-dimensional learning. Both contend that intelligent, conscious imitative behavior, rather than automatic imitative behavior, leads to concept development. Vygotsky's theories and the NCTM Standards agree on the value of cultural contextualization in the negotiation of meaning and reasoning skills, and on the importance of collaboration, communication and language in the process of concept development. Thus, it appears that Vygotsky's theories may offer appropriate and useful guidelines identifying the characteristics of effective uses of various technologies in the mathematics curriculum.

The Role of Technology in the Mathematics Curriculum

The Standards are purposefully general about specific types of technology and their uses. In doing so, they recognize the dynamic state of technological advancement and assume that ongoing change in technology will continue to impact the nature of mathematics. The focus of the standards is on the goals and objectives of the mathematics curriculum, relegating technology to the role of a facilitating tool for concept formation. It, therefore, seems appropriate to explore available technologies and to investigate their potential supportive application in the mathematics curriculum. Issues related to technology's role in mathematics education include content contextualization in the negotiation of meaning and reasoning skills, collaboration, communication and language in the process of concept development.

Mindtools

Jonassen (1996) discussed using "mindtools," which are computer-based tools and learning environments that have been "...adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher-order learning" (p.9). The functional role of mindtools is twofold: (a) to extend the learner's cognitive functioning during the learning process;, and (b) to engage the learner in operations while constructing knowledge that they would not have been able to accomplish otherwise. According to Jonassen, mindtools support a learning environment in which students are able to process information intentionally and meaningfully, to build on prior learning, to elaborate on new knowledge, to interrelate new knowledge with their prior knowledge, and to consciously reflect on their learning. He further suggested that mindtools might be enhanced through collaborative and cooperative efforts between and among students and teachers in the learning community. Mindtools, therefore, appear to offer a supportive structure to a Vygotskian approach to mathematics learning. Among the applications Jonassen lists as mindtools are databases, spreadsheets, and computer mediated communication. Each of these will be discussed in the following sections.

Databases

Databases are computerized record-keeping applications which allow easy entry and fast, flexible retrieval of information. The two basic components of a database are the field entries, which are the individual categories under which data is entered, and the record, which is a compilation of the representative fields. The database is a collection of records within which like categories of information are stored. This is similar to having a collection of index cards on which one would store the names, addresses, and phone numbers of all friends and family. The collection of index cards would represent the database; each index card is equivalent to a record, while each piece of information on the card equates to a field. Electronic databases are much more flexible than a system based on index cards, since the records may be sorted and organized by any part of the information in separate fields. This allows quick retrieval of any particular kind of information the student may wish to access.

Construction of databases requires that learners identify and classify the important underlying constructs of their information and the contextual relationships within the content. Students must analyze and comprehend the information they wish to store. A database management system can help students organize, interrelate and synthesize content information in a more meaningful manner. Using databases extends critical, creative and complex thinking skills (Jonassen, 1996).

Classification involves forming an organizational schema among elements in which noticing similarities and differences of objects is foundational (Sovichik, 1996). The ability to classify and to sort is fundamental in the hierarchy of mathematical thinking skills (Holmes, 1995; Kennedy, & Tipps,1996; Troutman & Lichtenberg, 1995). Hallmark to Vygotsky's theory of concept development is the child's movement from the ability to form relationships between and among physical objects on various levels to the ability to abstract properties independent of the physical object (Vygotsky, 1986). According to Vygotsky, the child's classifications progress from (a) an initial level of forming concrete and factual bonds which are based on external likeness, to (b) grouping by contrast where objects are categorized on the basis of a single trait on which the objects differ and thus complement one another, to (c) linking meanings in a chain-like manner where meaning is carried over from one link to the next, and finally to (d) fluid connections between and among objects.

Databases allow visual representation and provide a dynamic repository for information that may support the child from the most elementary through the most complex stages of classification and abstractions. Further, the construction, maintenance and use of databases encourage collaborative enterprises.

In a school setting, students could use databases with increasing complexity from the early grades throughout their secondary education. Databases can be used to reflect authentic information gathered by the students, and to provide a focus for the analysis and interpretation of the information stored. For younger students, this information may revolve around personal and concrete information (e.g., tracking weather information by day) while for older students it may contain data relative to more complex and more abstract subject matter (e.g., categorizing mathematical functions).

Spreadsheets

Electronic spreadsheets are a tool for organizing and manipulating numerical data; therefore they can help students manage numerical information and relationships. The spreadsheet is a two-dimensional matrix of cells. Columns are identified by letters, and rows are identified by numbers. Each cell may contain text, a numerical formula, a value or a function. Spreadsheets have three main functions that make them particularly conducive to the integration and extension of the mathematics curriculum: (a) storing information, (b) calculating functions which relate information, and (c) presenting the results of these calculations as well as the underlying information (Grabe, & Grabe, 1998; Jonassen, 1996; Roblyer, Edwards, & Havriluk, 1997). Many spreadsheets have the additional capability of easily converting numerical information into various graphical representations.

At the most fundamental level, developing and using a spreadsheet as a mindtool requires students to identify rules and to understand relationships. On more advanced levels, students generate new rules that describe and organize relationships (Jonassen, 1996). Jonassen cautioned, however, that if students merely engage in data entry they are engaging in lower level learning on the knowledge and comprehension levels. On the other hand, answering complex questions elevates learning to the application level. Students who are identifying, describing and classifying relationships in terms of higher order rules are participating in higher levels of critical thinking.

Vygotsky (1986) identified stages of abstraction that coincided with the various levels of classification abilities during the process of concept formation. At the most elementary level of concept development, Vygotsky maintained that the child is able to abstract whole groups of properties based on functional similarities (e.g., spoon, plate, cup). The child then progresses to abstracting a single property (e.g., cup and glass for drinking), and eventually to abstracting physical properties, impressions, and meaning or other attributes not tied to physical attributes. Vygotsky's contention supports Bruner's (1960) advocacy of teaching mathematical concepts on a continuum that progresses from the enactive (concrete representations) through the ikonic (pictorial and graphical representations) and finally to the symbolic (characterized by the ability to use words and other symbols as abstractions).

By nature, spreadsheets are much more abstract than databases; their appropriate use is limited to quantitative problem solving (Grabe, & Grabe, 1998; Jonassen, 1996; Newby, Stepich, Lehman, & Russell, 1996). A spreadsheet, when appropriately integrated into instruction, can be a higher level organizational and functional tool that may augment and support the child's conceptual progression through his or her ZPD. As with databases, spreadsheets may also promote increased collaboration and communication among students.

A classroom teacher may effectively and flexibly use a spreadsheet by structuring the content to appropriately reflect the students' ZPDs. For example, younger students could use more concrete experiences as data sources (e.g., by preparing different soap solutions and collecting data on the bubbles produced) while more advanced students might use more sophisticated data (e.g., survey information) from which they may draw abstract inferences. Used in this manner, spreadsheets offer promise both as an instructional medium and as an alternative assessment tool.

Computer Mediated Communication

Computer mediated communication (CMC) mediates communication between and among individuals and groups of individuals. Through computer technology and networks, individuals who may be as close as an adjacent room or as geographically distant as in another state or country may readily communicate either synchronously or asynchronously. Synchronous communication requires that participants communicate with each other at the same time and requires that connections be established for both receiving and transmitting information. Presently synchronous CMC requires more sophisticated linkages and is more expensive than asynchronous CMC. For these reasons, access to synchronous CMC is more limited in school settings.

Asynchronous communication does not require that those communicating be connected at the same time. Because the linkages are simplified and less expensive, it is more commonly found in school settings. Asynchronous communication may take one of three forms: (a) one-to-one, as in e-mail or use of search engines; (b) one-to-many, as in bulletin boards; or (c) many-to-many, as in conferencing or listservs. All of these uses permit communications to transcend time and space limitations.

Bednar, Cunningham, Duffy, and Perry (1992) contended that identifying and applying a particular learning theory to instructional design is crucial when using CMC. Khan (1997) developed a list of attributes that characterize CMC implemented over the World Wide Web. Many of these characteristics would lend themselves to meaningful inclusion in designing effective instruction that is consonant with Vygotsky's learning theories and with the NCTM Standards. Among those attributes that relate to instruction that is consistent with both Vygotsky and the Standards are: (a)

1. interactivity, which allows students to interact with teachers, peers, and online resources, and when asynchronous, also allows time for reflective learning and self pacing;
2. multimedia, which extends the potential to address all learning styles through the incorporation of various media including text, video, animation, audio, graphics and simulations;
3. open systems, which permit the learner to move outside of his or her immediate environment and to experience other resources, perspectives, and cultures;
4. distributed resources, which make available relevant information, a variety of materials, and easily attainable multimedia representations of a wide range of subject matter;
5. collaborative learning, which emphasizes cooperative efforts and communication, and which engages students in the negotiation and validation of meaning;
6. formal and informal environments, which support instruction on a continuum from instructor driven to student-centered discovery; and
7. authentic resources, which give students access to real world problems and to real world data.

Bannan and Milheim (1997) discussed general instructional methods that are useful with web-based instruction. The particular methods they presented take advantage of the characteristics listed by Khan, and also are consonant with a Vygotskian approach to instruction. Particular methodologies Bannan and Milheim described that directly support Vygotsky's theories include: (a) facilitation, (b) inside and outside collaboration, (c) apprenticeship, (d) content generation, (e) role-playing, and (f) modeling. The authors went on to discuss general activities that could be adapted to support group communication, course interaction, discussion, and facilitation. All of these are applicable to mathematics learning.

Asynchronous communication has given rise to more than just ideas; it has enabled a plethora of actual classroom projects sponsored by organizations such as the Eisenhower Clearinghouse, NASA, and PBS. Several of these will be described in the following section.

In 1996 and 1997, among the various virtual field trips offered by NASA, classrooms could enroll in a virtual expedition to Antarctica. While an actual scientific expedition was on site in Antarctica, students in the United States communicated via e-mail with the scientists in Antarctica and with other classes involved in the project. During the project, the scientists e-mailed to participating students not only their personal journals but also reports on activities, weather conditions, and problems they encountered. Students could also access these updates on a NASA-sponsored World Wide Web. The web site included relevant project information on scientific projects in graphics, audio, and video formats. The project provided a contextualized background for extension activities that gave students an opportunity to extend mathematical concepts by manipulating and interpreting data on various levels.

Additional asynchronous communications sites sponsored by diverse organizations, such as **Scholastic**, **Family Math**, and various colleges of education are available on the Internet or the World Wide Web. These sites engage students in on-line problem solving projects and in other math-related activities. They permit students to access databases of relevant information. Students may share their ideas and respond to others participants' ideas about particular questions or topics by subscribing to and participating in a listserv. A listserv is a common mailbox that receives mail and then distributes that mail to all subscribers. Topical sessions may be facilitated and moderated by an expert who guides discussions by providing pertinent questions. In this venue students can participate in collaborative processes to negotiate meaning, to validate methods, to resolve misconceptions, and to form and extend concepts.

As access to asynchronous CMC becomes more widespread among school communities, possibilities for supporting connectivity increase. Partnerships between classrooms could be formed with children in geographically distant schools. The children could share information about their communities, and compare data from their partner schools with their local data. Students could organize these data and develop databases and spreadsheets. Analyzing data from various locations could provide a basis for forming inferences about topics such as topography, industry, and population. Students would then be able to share their analyses with partner schools in order to validate and/or correct their inferences.

Conclusion

Vygotsky's sociocultural theories appear to support the change in direction of mathematics education that is advocated by the NCTM Standards. The standards call for students to become literate in a mathematical language through which they can articulate, communicate and solve problems. The change in instructional focus from a product to a process orientation finds affirmation in Vygotsky's theories of concept development, and the change in the roles of both teacher and student are consonant with Vygotsky's views of mediation and the ZPD.

Appropriately implemented, technology offers tools to the classroom that may promote high level thinking skills and support concept development. Asynchronous computer mediated communication allows students access to other individuals, information, and experiences that were previously unavailable in the classroom setting. CMC may be implemented in a number of ways to support the mathematics curriculum through increased collaboration and mediation.

As access to CMC becomes more universal, new ways of assuring supportive connectivity between and among classroom communities should be explored. Through technology, the perceived and functional distance between learning communities is becoming smaller. This new potential for communicating is important not only for students, but also for the educators who implement the curriculum. As we open the confines of time and space and virtually remove the walls that isolate the classroom, we will move into unexplored ways of communicating, learning, and teaching with technology. In this process, we must keep in mind that the nature of the child does not change and that our efforts to educate should be consonant with a sound theoretical base.

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Design Model for Learner-Centered, Computer-Based Simulations[1][2]

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A simulation has been described as "an event in which the participants have (functional) roles, duties and sufficient key information about the problems to carry out these duties without play acting or inventing key facts. [Participants] keep their own personalities but take on a job, duties, responsibilities and do the best they can in the situation in which they find themselves." (Jones, 1995)p. 18. According to this definition, the simulation is an ideal learner-centered tool for use in the classroom. After all, they place the learner in a central decision making role and allow her to encounter problems in a "real world" environment. In fact, one could claim that the simulation is a cognitive apprenticeship in an authentic environment. Simulations can be important tools for enhancing school learning environments.

Considering this useful application of simulations and the affordability and relative ease of development, why are we not seeing more workplace simulations developed for the schools? While simulation environments are extremely popular in industry and effective in job training (e.g., Schlecter, Bessemer, & Kolosh, 1992; Towne, 1995) few, if any, of these workplace training systems are transferable to the school setting. There are several reasons for this. At a practical level, the technology is typically too advanced and expensive to be feasible for schools to own. From a pedagogical point of view, the focus on job training will typically result in the performance requirements being too complex for use by children in school. Finally, from a curriculum perspective, most schools would reject a focus on direct job training with the goal being to prepare a person for a particular job. The role of K-12 education is to prepare students to be active, competent, and informed citizens in our society, not specific job training.

In order to change this trend and provide students with these potentially useful apprenticeship opportunities in either cognitive or, in a few cases, manual skill training, there are certain considerations which must be looked at. In order to realistically find a home for workplace simulations in the schools, we must look for simulations that use affordable technology, have performance demands that are feasible for K-12 students, and focus on introducing the learner to the culture of professions, i.e., introducing them to the basic skill requirements, the basic concepts, and the problems one encounters in the profession. In our search for workplace – or citizenship related – simulations of this type the primary examples we found were the work of Classroom Inc. and the work at the Institute for the Learning Sciences (ILS) (Schank, Fano, Jona, and Bell, 1993; Riesbeck, 1996). There are very few other examples. Overall, we were very surprised by the small numbers since these simulations seem to hold such potential within the learning theory framework of situated learning and considering that industry has found simulations to be particularly effective in job training (see, e.g., Towne, 1995).

It quickly became apparent in our search for computer-based simulation environments for schools that there is a shortage of these kinds of environments. We also quickly realized that there is little guidance for effective design of simulations of this kind. The research that does exist tends to take an information processing perspective emphasizing information transmission through practice and feedback (Reigeluth & Schwartz, 1989). While this kind of approach may be appropriate for simulations that teach particular information or skills, such as flight simulators, this approach may be sufficient. However, we would like to examine how one might design a simulation within a situated or constructivist framework. After we have examined the various aspects of this model, we will demonstrate its use by using it to examine one of the Classroom Inc. Simulations we have worked with, *The Chelsea Bank*.

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Design Criteria

So what does a situated learning or constructivist simulation look like? There are many sources we can go to for criteria to answer this question. For the purposes of our model, we look to two sources: the work of Savery and Duffy (Savery & Duffy, 1996) and the American Psychological Association's "Learner-Centered Psychological Principles." The view of learning we are taking, as already stated, is a constructivist one characterized by a set of philosophical views that include the idea that we learn through our interactions with the environment; puzzlement is not only the stimulation for learning, but also affects our organization of what we have learned; and knowledge evolves through both social negotiation and through each person evaluating the viability of their understandings. This basic philosophical basis leads to many exciting learning opportunities including those that simulations can facilitate.

The five primary criteria for the development of simulations we propose include:

- **The problem needs to be authentic.**
  Problems, goals, and obstacles need to be consistent with the environment which is being simulated so that the learner perceives both the environment and problems to be authentic. By maintaining this authenticity rather than artificially simplifying the task the student is working on, motivation stays higher and learners will be more likely to stay on task without coercion (APA, November, 1997).

- **The cognitive demand in learning are authentic.**
  In these kinds of simulation environments, the learner becomes the owner of their own decision making process. They get to choose how to go about finding the best solution they can. Again, this helps keep the intrinsic motivation level high. Further, the information gathered during engagement in the simulation is not artificially provided. Therefore, the student is experiencing what working in a particular environment is really like only without the high stakes associated with true workplaces.

- **Scaffolding supports a focused effort relevant to the learning goals.**
  Simulation environments are ideal tools for this kind of scaffolding. They can remove or lessen certain constraints that would get in the way of the learning process in the real-life counterpart of the simulation. For instance, in the case of the simulation we will examine in this paper, the student who is working as a bank teller does not need to worry about time considerations or about how many more people are waiting in the line behind the current customer. These kinds of real-life constraints would only get in the way of the students learning how to deal with the problem-solving tasks they are being faced with. It is important to point out that scaffolding should not be confused with simplifying the conditions in a non-authentic way. In our simulation, students still work with individual customers on real-life banking transaction, however, their work situation has certain elements removed from it that would only serve as distractors in the learning process.

- **Coaching promotes learning rather than directing or correcting performance.**
  In our work with the various simulation environments (Hawley, 1997; Hawley & Duffy, 1997; Duffy et al., 1996)we have worked with, this has proven to be a vital point. The role of the teacher in one of these environments should be one of a coach – a person who asks students questions on the cutting edge of their knowledge, pushes them to be reflective and thoughtful in their decision making, and enables the students to become independent problem solvers. As von Glaserfeld (1993) pointed out, "It is crucial for the teacher to get some idea of where they [the students] are (What concepts they seem to have and how to relate them)" (p.192). Savery and Duffy (1996) add to this saying that "It is essential that the teacher *value as well as challenge* the learner's thinking. The teacher must not take over the thinking for the learner by telling the learner what to do or how to think, but rather teaching should be done by inquiring at the "leading edge" of the learner's thinking" (p. 139).

  In our work to date, we have found a much higher instance of teachers either directing students by giving them explicit directions for how to play the simulation or standing back and letting the student work entirely independently with no guidance, reflective, or metacognitive activity. Our belief based on observations of many classrooms where the simulations were being used is that the students who are left alone or those who are directed through the simulation miss out on a large portion of the learning. As with any other mechanical tasks that students withstand, the simulation becomes something to work through just to get a grade. As the APA points out (APA, November, 1997), there are many different ways a successful learner can create and use a variety of reasoning strategies. A teacher who is acting as a coach allows the students to explore the various ways of thinking about a problem, possibly through questioning students about their strategies, thinking aloud about her own strategy, or having students share the different approaches they took to solving the problem with their classmates. It is this kind of teaching style that is necessary in order for the computer-based workplace simulations to be most effective.

- **Reflection supports abstracting, synthesizing, and extending the learning.**
  "Doing" the simulation is accompanied by "reflecting" about what happened during the simulation. It is in this reflection process that learners can begin to synthesize what they have just done. The reflection activities can take place as class discussions, small group discussions, or journal writing assignments. Special emphasis might be placed on the discussion approaches to reflection considering the social negotiation aspects of learning – we learn by bouncing our ideas off of other people who may have different ideas than our own.

- **The environment should be engaging.**
  While everything listed so far should lead to an engaging environment, special attention should be paid to this aspect. If the students buy into the simulation, they will be more likely to remain engaged and maximize their learning experience.

With these criteria as a basis, we will now explore *The Chelsea Bank*. Keep in mind that the ultimate goal of this simulation and other simulations of this type, is the development of problem-solving skills in the students who use it. This simulation goes a step further in that it requires not only good problem solving, but also puts some emphasis on ethical problem solving and issues of customer service associated with the everyday work world.

The Chelsea Bank

An Overview of the Simulation Package.

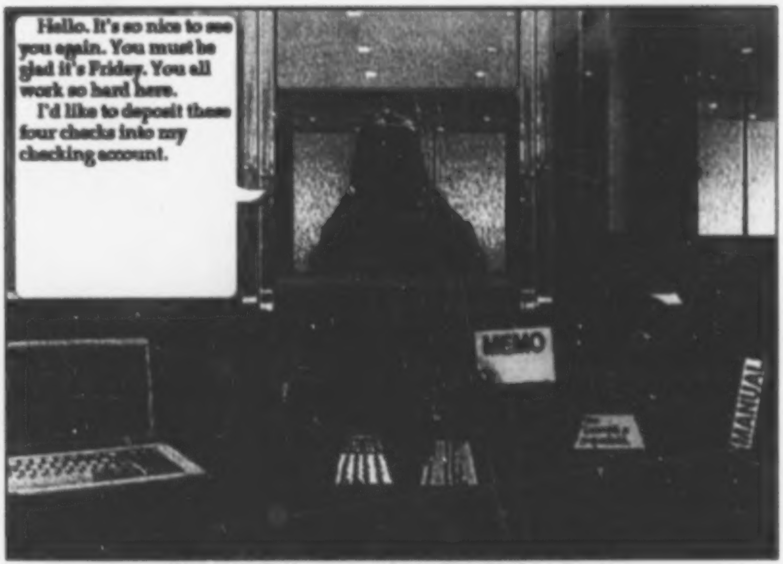
The *Chelsea Bank* package is more than a piece of software. It includes the software, a teacher's guide, an audio tutorial workbook, and extra software focusing on savings and checking accounts. As with all of the Classroom Inc. Software, the program can only be used by teachers who have gone through the Classroom Inc. training program which focuses on not only the technological aspects of integrating software into the classroom, but also using the software in a way that is consistent with the guidelines we have outlined. Classroom inc. Is extremely concerned about the implementation of their programs in the classroom and has spent several years working on their training programs. Beyond the training and written materials, adoption of the software also ensures the teacher a support network. Teachers using the simulation get help through site visits and through communications with the Classroom Inc. offices.

Central to the teaching strategy set forth by Classroom Inc., the students work on the program in groups of three to four students. This is done in an effort to help the students learn to work in a team. It is also consistent with the idea that "Learning is influenced by social interactions, interpersonal relations, and communication with others" (APA, November, 1997).

Also central to the Classroom Inc. philosophy, activities should be done before and after the actual scenarios in order to help students tie the computer-based activities to real-life activities. In some cases, these activities are transfer ones in which the students have to talk or write about things that have happened in their own lives that parallel situation in the scenarios. Other activities have the students build on the world presented to them in the computer by doing things such as taking a fieldtrip to the bank, running a mock economy, or designing an ad to hire a new teller.

An Overview of the Simulation.

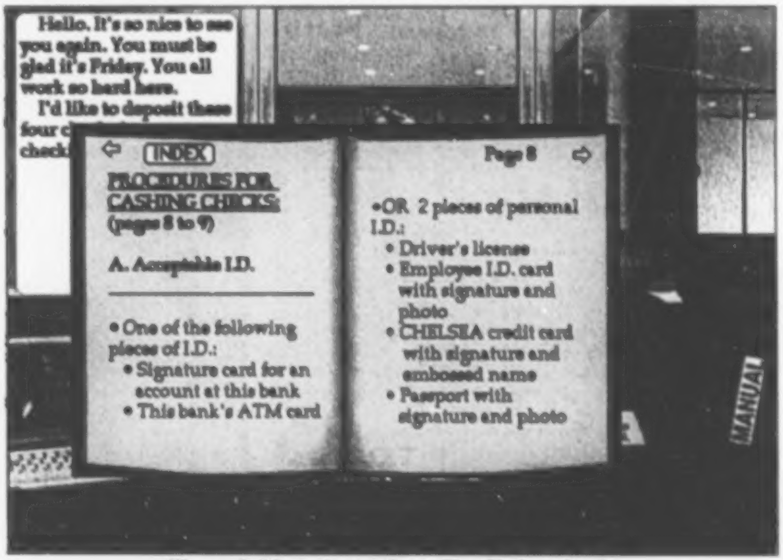
The Chelsea Bank consists of 15 scenarios in which the groups of learners act as either a bank teller (8 scenarios) or a customer service representative (7 scenarios). The learner is asked to do standard banking activities including cash a check, deposit a check or cash, open a loan or credit card, handle customer complaints, or open a checking account.



Hello. It's so nice to see you again. You must be glad it's Friday. You all work so hard here.
I'd like to deposit these four checks into my checking account.

Figure 1. Teller screen from *The Chelsea Bank.*

As an illustration of how the simulation works, we will consider one of the teller situations. Each scenario starts on a new day. The screen show the student the view from behind the teller desk. The students can see the lobby of the bank. Once they click the "Next" sign, the students read a short note about who the new customer is and what he or she would like. Often the information given in this introduction includes personality information, e.g., your best friend walks up to your window and is in a hurry or a grumpy customer approaches your window. Then, a customer walks up to the window and places his or her transaction under the window and says (via text box) what he or she wants. At this point, the students must act as the teller and decide what to do. They must decide if and how the transaction will be completed.



Hello. It's so nice to see you again. You must be glad it's Friday. You all work so hard here.
I'd like to deposit these
four c
check

⇦ INDEX

PROCEDURES FOR CASHING CHECKS: (pages 8 to 9)

A. Acceptable I.D.

- One of the following pieces of I.D.:
  - Signature card for an account at this bank
  - This bank's ATM card

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•OR 2 pieces of personal I.D.:
  - Driver's license
  - Employee I.D. card with signature and photo
  - CHELSEA credit card with signature and embossed name
  - Passport with signature and photo

Figure 2. Manual page from *The Chelsea Bank.*

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In order to facilitate the decision-making process, the program includes a variety of resources that the students can use, if they choose, in order to make a decision including"

- the bank policy and procedure manual
- customer accounts database
- credit report database
- the materials submitted by the customer
- multiple points of view (when dealing with customer complaints)
- application forms when they are appropriate

Once the learners make a decision, they go to a "decision" screen where they are presented four or five alternative decisions and they must choose one. These decisions are always available during the scenario, meaning that the students can make a decision with no evidence to support it, thereby bypassing the problem-solving process entirely. They could also choose to use a process of deduction to solve the problem by looking at the choices early in the decision-making process, then disproving them to find the "right" answer.

Once a choice is made, the students are asked to reflect on their decision. They are asked to describe the rule of good banking they used to solve the problem, as well as what the results to themselves, the customer, and the bank will be because of their decision. The program provides a space for writing that can be printed out, but without teacher guidance, there is no guarantee that the students will answer the questions.

Once the reflection questions are answered, the students have an opportunity to read about the consequences of their decision. They can also read the consequences of the choices they did not pick.

Evaluation of *The Chelsea Bank*

To answer our question about *The Chelsea Bank* – to what degree does the design of the program support the development of problem solving skills in completing banking transactions, in interacting with customers, and in making ethical decisions – we will evaluate it using the design criteria set forth in this paper.

Is the problem authentic? The problems set forth in *The Chelsea Bank* are certainly authentic. This is one of the strengths of the program. The authenticity of presentation includes the types of transactions presented and the kinds of customers that are dealt with. A further strength of Chelsea is that the students actually perceive the situation as authentic. In our interviews with students at half a dozen schools, the students consistently commented on how real the simulation was – that it was like really being at the bank.Furthermore, they described the scenarios by talking about the personalities of the customers and they should have dealt with them. We were surprised, given the low fidelity of the interface, that both middle and high school students responded enthusiastically as to the authenticity.

Are the cognitive demands in the learning environment authentic? The next consideration in a discussion of authenticity is "Are the cognitive demands authentic?' That is, does the program demand the use of a problem solving model that is similar to the one a real bank teller or customer service representative would have to use on the job? *The Chelsea Bank* proves to be divided in this area.

- Learner control of decision making. The students are in control of the decision-making process throughout the simulation. Once the customer provides the transaction the students are dealing with, they decide what they need to know and which resources are appropriate. This is a student-controlled environment without any feedback. The learner is responsible for analyzing the problem and using the available resources to find a solution. This empowerment of the learner in the decision making process is a real strength of the software.

- Pretraining and hints. The Teacher's Guide provides guidance for teaching vocabulary and raising salient issues before beginning the scenario. In the context of the computer delivery, there is also a memo which provides a hint about the salient issue. These kinds of hints and pretraining change the demands on the learners so that they no longer have to develop the strategies for working in an authentic environment, rather they learn to seek and interpret hints – a different activity from problem solving in the sense we are trying to promote. For example, by pretraining vocabulary, we have removed the necessity for self-monitoring of understanding on the part of the students. They have been spoon-fed that which they might not have known and can move on to the simulation and not think about it anymore.

- Multiple choice solutions. The use of multiple choice answers removes the need for hypothesis formation and problem definition by the students. The students can go immediately to the solution options to identify relevant variables and outcomes to consider. Even if the teacher prevents this shortcut tot he answers, the students still know that they do not need to formulate their own response to the situation. Rather, they need only have a "sense" of what the right thing to do is. There is no need for a rationale. In our work with one of the other Classroom Inc. Simulations, we found that students who described the simulation problems as being pretty easy were, at times, completely unable to provide a problem statement or reasonable solution to similar problems when taken out of the multiple choice context.

  We do see some benefit from the use of multiple choice answers as a scaffolding device for the students. An effective problem solving process is to generate hypotheses on what might be wrong and how to respond to a customer – exactly the sort of thinking reflected in the multiple choice answers. However, the students should be asked to generate their own hypotheses in addition to those in the multiple choice answers. Then the students should be asked to evaluate each of their hypotheses to choose the one that is the most correct and ethical. There should be a gradual transition throughout the simulation moving the students away from the multiple choice answers altogether so that by the later scenarios, the students are generating and evaluating only their own hypotheses and providing their own solutions to the answers.

- Lack of interaction with customers. One of the stated objectives for this simulation has to do with the development of interpersonal skills through interaction with customers. The fact that there is virtually no interaction with the customers truly limits the learning that can occur with regard to this objective. While the interpersonal problems are authentic, the cognitive demands on the students with regard to interpersonal skill are not. Given the low cost computing environment in this simulation, it is unclear to us how interactions could be incorporated. This is one of the many instances where follow-up discussions and role plays could help fill in the shortcoming of the technology.

Does scaffolding help to focus the learning objectives? There are a few issues worth exploring for this discussion.

- Lack of time constraints. One of the most effective uses of scaffolding in this program is in removing the time constraints that a bank employee would normally face in making a decision. The goal is to engage the students in the problem so they begin to understand the types of transactions, strategies for determining how to complete the transaction, and the development of skills needed to carry out that analysis. Removing the time constraints places emphasis on developing these skills.

- Simplified banking tools. The resources are representative of what the employees uses but they are greatly simplified. It is a question of the skill levels of the students as to whether the materials are so simple as to detract from the problem solving. For instance, the student is presented with two possible databases of information to use in working with customer. They can do a credit check or they can look at account balances. The program has only included the names of the customers who need to have their credit checked in the credit check database and all of the customers in the simulation who currently have accounts at the bank in the account information screen. By doing this, the programmers have prevented students from realizing the difference between the two kinds of information. In the students we observed in several classrooms, we continually saw students going to the credit check screen to verify account information. When the person they were checking on did not appear in the database, the students either went to the accounts screen or assumed that the customer did not have an account at the bank. Neither of these situations is promoting the kind of thoughtful approach to resources the students need to be developing.

- Truncated task. The simulation takes the student only to the decision making process. This supports the analysis of the bank transaction – but there is no time spent on the implementation of the solution. However, developing interpersonal skills requires an interchange between the learner and the customer – the learner needs to be able to try out different ways of responding to customers to see what the impact is. Thus, this task truncation supports the banking objectives, but not the interpersonal skills objectives.

Does coaching promote learning rather than simply directing or correcting performance? There is no coaching in *The Chelsea Bank* and there are no clear guidelines give to teachers, either in the Teachers Guide or in the training they receive, on how to coach the students during their work on the scenarios. As a consequence, there is no requirement to any more than guess. We have seen in our three years of working with this product that students are indeed engaged in their work on the scenarios. However, they receive little or no support to help them evaluate the quality of their work. Indeed, there is rarely any attempt to coach a problem-solving process with regards to banking practices, interpersonal skills, ethics, or working in groups (Hawley & Duffy, 1997). Teachers seem to have no sense for what the problem solving process might look like and students do not become involved with the evaluation of their own problem-solving skills in the course of their work on the simulation. Teachers often reported to us that they felt that if the students were engaged and working together, they were learning about problem solving and groupwork.

We are starting to be encouraged by a slow shifting in the teachers who are using this program. In our interviewing of teachers over the past two years, we have seen a variety of opinions on teacher role and interpretations of what the roles mean as far as the teacher's job is concerned. It is apparent that the teachers have absorbed the jargon of what they are supposed to be doing. When as about their role during the simulation, they offered explanations such as:

> You have to help the students think through their thoughts and their decisions about what they're doing and why they are doing it. They know what they are doing. But, to help them to understand why they are doing it is really very important. So, by walking around the room, even during their pre or post-scenario discussions, a lot of "Why?" questions need to come up. Because then the teacher is better able to understand why the students are doing the things they are doing even when they are not doing The ***Chelsea Bank***. So, it helps the teacher to better understand where the kids are and what they are thinking about. (Hawley, 1997)

However, the implementation of these beliefs is a slow one going against the traditions of classroom teachers. It is the facilitation of these skills that the professional training being done by Classroom Inc. is starting to really focus on.

Does reflection support abstracting, synthesizing, and extending the learning? Too often we are involved in projects where the emphasis is on doing, with little encouragement to step back from the doing and think about what was learned, what still needs to be learned, and where it might be useful. In our minds this is critical to the learning process for it is the abstracting or indexing of what was learned that makes the experience useful in the future.

In *The Chelsea Bank* we found two kinds of reflective activities: a post-decision writing activity that is part of the software and certain teacher-directed activities outlined in the Teachers Guide. The computer-based reflective activity involves the student stating the problem they just solved, naming the banking principle that helped them solve the problem, and talking about the impact their decision will have ont the bank, ont he customer, and on themselves as the teller or customer service representative. Consistent with the goals of reflection, the student may leave the reflective activity and return to the decision making screen or review any of the materials presented in the scenario at any point. The decision itself may be changed at any point up until the reflection activities are completed and the students submit them as their final answer. This ability to change the decision at any point during the reflective activities is one of the excellent features of this simulation.

The ability to act on this reflection is wonderful, however, the reflective activity itself is limited for three reasons. First, the same questions are asked each time which prevents them from being contextualized to the situation.Second, there is no established purpose for the reflection – to the students it appears simply as a writing task. Finally, the focus of the reflection is on the outcome and not on the process. There is no attempt to abstract the problem-solving process or help students identify the key principles guiding decision making.

The post-scenario reflective activities outlined in the Teachers Guide hold considerable potential. However, these activities tend to focus more on interpersonal skills and also tend to move toward new situations rather than reflecting on the situation that just occurred. While both of these are valuable activities for other reasons, such as transfer of skills and development of social empathy, they do not support the reflective activity that is at the heart of learning.

Is the environment engaging? In the case of *The Chelsea Bank*, as well as the other Classroom Inc. simulations, this is one of the most striking things. Even though the simulations are relatively low-fidelity to allow for the widest possible audience, the kids become totally engaged in the simulation. In fact, it was this high level of engagement that first struck our research team – in every class visited, the kids were huddled in groups actively working on problems. Even in our discussion with the students the level of engagement was apparent. The students talked about the characters as if they were real people and the decisions as if they were really made.

Summary and Conclusions

Too often computer simulations are viewed as standalone applications without recognizing the critical role that teachers play in their successful implementation. This is true even though we have a long history of data indicating that the teacher variable can override virtually any "technology" variable in the educational process. It should also be clear from this discussion that the teacher plays a critical role in coaching the students during the simulation and in supporting reflection. The simulation can provide a "doing" environment but we would argue that the situated role of the teacher is essential to creating a learning environment (Chaney, 1996; Duffy & Chaney, in press). With the teacher support in coaching and reflection, simulations which are currently viewed as games because of the focus on doing, could become effective educational tools.

The Chelsea Teacher's Guide offers no guidance on what the teacher should be doing during the simulation. In our discussions with teachers, there was a frequently expressed opinion that the simulation was successful if the students could work through the scenarios with assistance. There was also a belief that simply by engaging in this problem solving environment and working in groups the students were learning transferable problem-solving and groupwork skills. We would like to end this discussion by emphasizing that thinking about coaching and reflection while students work in small groups is no easy task. This represents an important area for future research, some of which we are currently involved in, which explores what the role of the teacher should be and what other scaffolding activities might maximize the learning potential of these simulation environments.

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Open-Ended Learning Environments: A Theoretical Framework and Model for Design

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Abstract

One form of learning environments that continue to draw attention and interest are those open-ended in nature. Open-ended learning environments (OELEs) are learner-centered; the instructor plays the role of a facilitator rather than that of the focal point for learning. While the opportunities afforded by OELEs for enhancing learning are substantial, considerable challenges arise in their creation and implementation. The purpose of this paper is to present a framework and model for the design of OELEs. We first present an overview of OELEs. Next, assumptions and issues associated with the design of OELEs are discussed. Following the establishment of a framework for understanding the challenges and opportunities afforded by OELEs, a theoretical model for designing OELEs is introduced. Finally, guidelines will be offered to assist in the use of the model for the design and development of learning environments based on open-ended constructs.

One form of learning environments that continue to draw attention and interest are those open-ended in nature. Open-ended learning environments (OELEs) afford and support exploration and experimentation; problem solving, critical thinking, and multiple perspectives are essential processes in these environments [for a more complete description of OELEs, see Hannafin, Hall, Land & Hill, 1994]. OELEs are learner-centered; the instructor plays the role of a facilitator rather than that of the focal point for learning. Individual experiences and contexts are emphasized as learners cultivate cognitive processes to support understanding in OELEs. The development of strategies and processes are focal points for demonstrating growth in understanding (Land & Hill, 1997; Papert, 1993).

While the opportunities afforded by OELEs for enhancing learning are substantial, considerable challenges arise in their creation and implementation. OELEs come in many varieties (simplistic and focused; complicated and limitless) and can be manifested in several settings (face-to-face instruction, distance learning environments, computer assisted instruction, etc.). Like most learning situations, well-designed and developed OELEs have the ability to empower, liberate, and expand the orientations of their participants [for related discussions on the value of sound instructional design in other learning situations, see Moore & Kearsley (1996); Willis (1993)]. At the same time, OELEs are demanding, and can be disorienting, even unsettling, for those engaged in these environments. The learners, as well as the instructor, are placed in roles not traditionally held in formal learning environments; furthermore, the processes associated with these environments (problem solving, critical thinking, etc.) are ones which demand considerable work by all participants (Hannafin, Hill, & Land, 1997). Designing and developing learning environments that empower the user, are intuitive and self-evident, and inclusive in orientation is a formidable challenge (Norman, 1988).

The purpose of this paper is to present a framework and model for the design of OELEs. We first present an overview of OELEs. Next, assumptions and issues associated with the design of OELEs are discussed. Following the establishment of a framework for understanding the challenges and opportunities afforded by OELEs, a theoretical model for designing OELEs is introduced. Finally, guidelines will be offered to assist in the use of the model for the design and development of learning environments based on open-ended constructs.

Overview of OELEs

OELEs coordinate application of a variety of tools and resources for use in addressing situated, authentic problems (Hannafin, Hill, & Land, 1997). Technology is often used as a mediator of the process, providing learners with electronic means to search vast databases of resources and manipulate variables and concepts. Yet, fundamentally, OELEs support student-centered understanding -- the learner is at the center of the environments both in terms of decisions for using the available resources and as the party with the primary responsibility for learning. As such, OELEs have relied heavily upon theoretical views from constructivists, who assert that understanding is best achieved when it is individually driven by, or constructed by, the learner (Jonassen, 1991; Phillips, 1995). In essence, OELEs support learner-centered construction with opportunities to relate new knowledge to personal experiences from a problem-based, activity-intensive orientation. Technologically-based tools and resources are used as means to support the constructive process.

OELEs provide interactive, complimentary activities that revolve around problem-based contexts and support individual sense-making processes (Hannafin, 1992; Hannafin, et al., 1997). OELEs are comprised of several key characteristics that enable them to support divergent student needs and establish the conditions for enriching thinking. Several of these key characteristics include the following: (1) use of meaningful, complex contexts (2) provision of tools and resources; (3) learner reflection and self-monitoring; and (4) social, material, or technological scaffolding.

Use of Meaningful, Complex Contexts

One common characteristic of OELEs is the use of broad, problem-based contexts that form the adhesive for all conceptual activity. Problem-based contexts serve three primary purposes: (1) to orient learners to the activity; (2) to provide an guide for applying what is known and evaluating what is not known; and (3) to assist learners in connecting formal concepts to everyday applications of them.

Scenarios or cases, for instance, are often used to guide learners in exploring the complexities of a topic. Such contexts often focus on everyday problems (e.g., environmental pollution for studying chemistry concepts; swimming pools for studying buoyancy and water displacement; corporate cases to study management principles; real patient cases for learning about radiology, etc.). Everyday problems are used to increase the likelihood that learners will readily identify how concepts can be *applied* in a given setting. Complex contexts are used as a way to assist learners in thinking about the content in ways that are consonant with a community of practice. It is not likely, for instance, that scientists learn about science by reading and memorizing laws; rather, they use an inquiry-based approaches for hypothesizing and predicting outcomes based upon a collection of empirical data. OELEs strive to mirror the holistic thinking practices of experts, within boundaries accessible to novice learners.

Complex contexts provide an anchor for making sense out of discrete pieces of information. Rather than memorize or learn content in absence from an applied context, information is learned as a result of *needing to know it* in order to solve the problem. Problem-based approaches in medical schools, for instance, teach learners to use hypothesis-driven approaches -- i.e., generate hypotheses about a case to explain the data with incomplete understanding of the related knowledge base (Hmelo, Gotterer, & Bransford, 1997). Once hypotheses are generated, data is searched and selected that confirm, formalize, and/or refute the hypothesis. Consequently, new data or information becomes meaningful as its potential for *use* is evaluated in light of a driving context and hypothesis. OELEs use complex, meaningful contexts to assist learners in building formative theories and to then search for new information to confirm, elaborate, or refute the hypothesis.

Provision of Tools and Resources

OELEs use tools and resources to assist learners in accessing both sources and perspectives related to the content under study. Often, a range of resources are provided that serve as repositories of information (e.g., CD-ROMs, encyclopedias) that can be brought to bear to solve a particular problem. For instance, problem-based approaches for medical school training may incorporate databases of resources such as patient X-Rays, disease diagnosis references, or patient histories. Students using a microworld on physics concepts may access resources about formal concepts such Newton's Laws, or a database of student perspectives regarding how the concepts manifest in everyday life (e.g., hitting a baseball; riding a bicycle; slowing down in a car, etc.).

Environments can also be designed to facilitate the *construction* of resources by learners. For instance, students can learn about fractions by designing and constructing educational software for teaching younger children about fractions (Harel & Papert, 1991). Similarly, tools such as *Intermedia* utilize a networked multimedia system where learners construct a "web" of concepts, and share them communally with other students. The use of resources, or opportunities to construct resources, provides a rich environment for extending understanding.

Tools for constructing and manipulating understanding are used to promote learning that is more concrete and capable of being tested. Tools, such as spreadsheets or word processors, provide opportunities for user-centered activity. In learning environments, tools help learners to manipulate features and processes. Some tools, such as those found in simulations and microworlds, allow learners to manipulate concepts by varying parameters and/or physical models (e.g., vary force and direction of an object in space, [Rieber, 1992]). Computerized tools can be used to select text for electronic notebooks, create hyperlinks between sources of information, or perform calculations (Hannafin, 1992). Tools allow learners to test complex theoretical concepts in concrete ways (Hannafin et al., 1994).

Learner Reflection and Self-Monitoring

The student-centered learning process hinges upon the learner's ability to monitor learning needs and to place into action planning and evaluation approaches. OELEs typically emphasize activities that induce and facilitate reflection on the learning process. The CSILE environment, for instance, is designed to facilitate metacognitive thinking through the use of prompts to generate questions, hypotheses, or theories (Scardamalia et al., 1989). Other environments facilitate reflection of scientific inquiry or critical thinking skills by embedding activities that induce connection of hypotheses to observations (Lewis, Stern, & Linn, 1993). By virtue of their design, OELEs require complex thinking skills and a variety of strategic and evaluative processes. For this reason, OELEs guide learners in using these techniques by embedding the reflective requirements of the activity into the environment itself.

OELEs often require the creation of end-products that make learner reasoning overt. It is not enough, for instance, for a learner to simply manipulate variables in a microworld or develop hypotheses without understanding *why* they are relevant. Instead, OELEs require learners to communicate what they have learned through the development of "artifacts" that reflect both the product of their understanding and/or underlying argumentation. Project-based approaches, for instance, often revolve around the creation of learner-generated multimedia products. Thus, a preservice teacher learning how to incorporate technology into the curriculum, might develop an example lesson indicating how they would use technology in the classroom. Accompanying this product might also be documentation regarding how it solves an identified problem and how technology is an instrumental part of the solution. Consequently, reflective activity is supported through both en-route and end-product requirements of the activity. En-route reflection is necessary for learners to ask driving questions, identify "needs-to-know," and implement strategic plans during the open-ended learning process. End-product reflection is necessary to justify or argue what has been constructed.

Social, Material, or Technological Scaffolding

OELEs rely on the learner to direct the learning process, formulate goals, and interpret events within the environment. Social, material, or technological support is also provided to assist learners in the knowledge construction process. Many OELEs, for instance, utilize teacher-student and student-student interactions to model or scaffold reflection and performance (Hannafin & Land, 1997; Palincsar & Brown, 1984; Scardamalia & Bereiter, 1985). In such environments, teachers and students coach, model, and share strategies within a problem context (Collins, Brown, & Newman, 1989). Learners contribute to continually evolving archives of knowledge that are shared and used as the basis for evaluating individual understanding (Scardamalia et al., 1989). Such scaffolding emphasizes the sharing of sense-making processes and the progressive negotiation of meaning.

Technology is also used as a way of scaffolding performance. Technology-based environments often "...provide models, opportunity for higher level thinking, and metacognitive guidance... in a learner's zone of proximal development" (Salomon, Globerson, & Guterman, 1989, p. 620). That is, technology is used in ways to support understanding that would be difficult, if not impossible, to support otherwise. For instance, visualization tools used in microworlds such as *Geometer's Sketchpad* and *Interactive Physics* allow learners to construct models or objects and rotate and manipulate them in order to test their parameters. Technological tools can scaffold opportunities for learning by altering both the experiences available to learners and the cognitive requirements of the learning task (Salomon, 1986).

Assumptions and Issues Associated with the Design of OELEs

A variety of isolated case studies of OELEs have been detailed that discuss the design and development considerations specific to the given environment (see for example, Cognition and Technology Group at Vanderbilt, 1992; Rieber, 1992; Lewis et al., 1993). Research on these environments has been promising, but often detail the seemingly unique requirements and features of a particular environment. General design guidelines and heuristics have occasionally been offered, but little has been done to synthesize the common features and assumptions underlying these environments, nor to present a unified theory of design. Consequently, apart from isolated conceptions of OELEs, little is understood regarding how to design learner-centered environments that cross content areas and specific uses of technology (Hannafin & Land, 1997).

The concept underlying OELEs, however, is not limited to solely one kind of technology-based environments. Rather, OELEs comprise many forms, often with few discernible similarities. This makes it difficult to identify common characteristics to use as the basis for design. This section, then, will discuss common assumptions that are manifested across diverse environments.

Assumption One: Understanding is best achieved when situated in relevant contexts.

One assumption underlying use of OELEs is that knowledge, context, and process are inextricably tied (Brown, Collins, & Duguid, 1988). This implies that learning of discrete information, decontextualized from its application, will remain "inert" (Whitehead, 1929) or unable to be used. Rather than isolating information, OELEs embed relevant knowledge within problem contexts. Thus, learning of specific information takes place as a consequence of needing to know it and apply it to solve the current problem. *Science Vision* (Tobin & Dawson, 1992), for instance, immerses students in learning science concepts through use of an authentic context. Students learn about force and motion concepts, for instance, by using them to build a virtual roller coaster. They learn chemistry concepts by resolving problems related to a polluted river. Information that is anchored in relevant and situated contexts is viewed as integral to learning how and why information is meaningful.

Furthermore, situating knowledge within realistic practices requires learners to model the processes that they may ultimately practice. That is, the *process* required to apply information to solve problems is consonant with the manner in which experts or practitioners use them. In this sense, the process of learning is not disconnected from the process by which knowledge and skills will be ultimately used. Preservice teachers, for instance, typically take courses on learning how to integrate technology into the curriculum. An authentic context for learning these types of skills would incorporate learning of the technology *with* learning how to apply it in the classroom. Yet, it is more typical that they learn the discrete "how to's" of using technology, without learning how to *think* about conceptualizing technology-based learning experiences. Using situated contexts helps to assure that knowledge is not separated from either the process or context of applying it.

Assumption Two: Learners must take more responsibility for monitoring, and reflecting upon, the learning process.

OELEs assume that learners have the metacognitive awareness to take direction of the planning, implementing, and evaluation process. Through guidance from the system, learners are provided with hints, orienting scenarios, help options, and direct instruction if needed. Presumably, with more opportunities to make choices regarding what, when, and how to learn, learners evolve greater responsibility for their learning. Evidence also suggests that learners are becoming increasingly compliant in their thinking -- seeing the learning task as one of matching their ideas and theories of an external agent (typically a teacher) (McCaslin & Good, 1992). For these reasons, OELEs provide learners with opportunities to derive and test individual sense-making processes.

To be effective during open-ended learning, learners must monitor their thoughts and actions. Learners interact based upon metacognitive awareness of their understanding and the perceived need to validate or challenge their understanding (Perkins, 1993). This includes decisions to pursue additional practice, search for definitions or information, test a hypothesis, create a "what if" scenario, or take notes. Learners must be able to locate, select, organize, integrate, and use relevant information if they are to generate products and/or understanding. Similarly, learners must evaluate the adequacy of their approaches during open-ended learning (Belmont, 1989). Learners are assumed capable of meeting these metacognitive requirements *if* they are supported by system-learner, teacher-learner and learner-learner interactions.

Assumption Three: Understanding is best supported when learners connect personal experiences with formal concepts.

One assumption of OELEs is that personal beliefs, experiences, and conceptual schemata support current, as well as provide the foundation for new, understanding (Hannafin, 1992). Background knowledge and experience form the conceptual referent within which new encounters are organized and assimilated (Piaget, 1976). Background context influences the choices learners make in the environment, the extent to which they persevere, and the types of goals they set. Accordingly, learner use of prior experiences as a referent for understanding is foundational to the design and development of OELEs.

OELEs often utilize problem contexts that are accessible to learners' everyday experiences. Rather than present information in the abstract, it is presented within rich, concrete experiences that can be manipulated, compared, and explored. By allowing learners to have concrete experiences with phenomena, they are given the opportunity to reshape ongoing theories that are based upon personal experiences. For instance, the *ErgoMotion* environment supports learners in the development a virtual roller coaster, in order to explore basic mechanics principles. It is assumed that learners will utilize their experiences in riding roller coasters as the basis for making decisions and making sense out of the events in the environment. As learners connect system experiences with prior experiences, they access existing frameworks to be build upon. This knowledge can then be used to enrich or elaborate the formal concepts under study, as they are integrated into prior experiences. It is commonly believed that integrating new knowledge with existing conceptions results in more meaningful learning (Mayer, 1984).

Assumption Four: Learning is a byproduct of progressive negotiation and interpretation of meanings.

OELEs support personal theory-building through opportunities to generate, test, and revise ongoing theories-in-action (Land & Hannafin, 1996). It is assumed that learners hold initial, although often incomplete or naive beliefs, that are progressively refined through interaction with the environment. These beliefs form the foundation for understanding and establish assumptions that can be tested while engaging the system, teacher, or other students. Microworlds and simulations, for instance, allow learners to generate and test "working models" of their understanding. By varying parameters and hypothesizing their outcomes, learners test assumptions and revise thinking based on observations.

OELEs are designed to assist the leaner in the process of *angling*, or considering multiple perspectives, during the learning process. Multiple perspectives from teachers, experts, or peers are coordinated to form a knowledge base from which learners evaluate multiple sources of meaning. *Bubble Dialogue* (Language Development and Hypermedia Research Group, 1992), for example, allows learners to share dialog, viewpoints, and perspectives. Similarly, the *Knowledge Integration Environment* (Linn, 1995) uses web technology to support learners in sharing databases of learner-constructed evidence for evaluating scientific phenomena. Varied methods and perspectives are viewed as critical to developing deeper, divergent, and more flexible thinking processes.

Summary

OELEs draw upon a variety of theoretical foundations and methods in their design. Yet, despite the differences among isolated approaches, most OELEs share a common set of key characteristics and assumptions. The common characteristics and assumptions can be used to leverage the effective design of these environments. What remains to be discovered are "best practices" and/or "best models" for doing so.

Theoretical Model for the Design of OELEs

Key characteristics and assumptions of OELEs, as well as our experiences in the development of OELEs, were used to guide the creation of a theoretical model for the design of OELEs. The model depicted in Figure 1 is an example of how elements within the model overlap and build upon one another. What follows is an explanation of each phase of the model. The reader is reminded that this is a theoretical model; continued exploration and use of the model for designing and developing OELEs is needed.

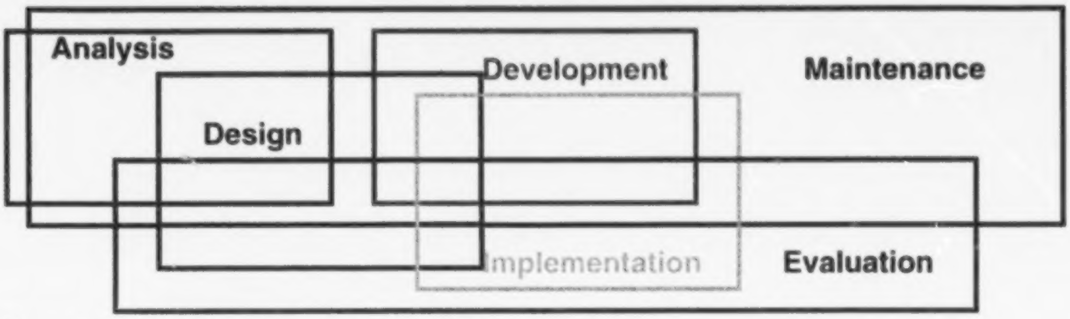

Figure 1. Theoretical model for the design of OELEs.

Analysis

The analysis phase leads the way in the design of OELEs, as it does in most instructional design models (Dick & Carey, 1997; Kemp, Morrison & Ross, 1998; Smith & Ragan, 1993; West, Farmer & Wolff, 1991). Analysis in OELE design places the designer in the role of sleuth, seeking to discover information about the environment in which the OELE will be implemented (face-to-face or other) and the participants in the OELE, including the learners and the instructor. OELE analysis also involves the exploration of the task, both from the learner's and educator's perspectives.

Environmental analysis. Environmental analysis is a sub-process in the analysis phase. As defined by Tessmer (1991), environmental analysis involves "...the analysis of the context in which the instructional product will be employed, of the physical and use factors of the instructional environment, and its support environment (p. 9). The goal in environmental analysis is to describe *where* the product will be used, *how* it will be *used*, and *how* it will be *sustained* in its use. Several areas are explored during environmental analysis.

1. *The driving factors behind the creation of the OELE.* For example, one question asked during the environmental analysis is "why is the instruction important? In asking this question, the designer seeks to provide a societal context for the OELE (West, Farmer & Wolff, 1991). Examples of why the instruction may be important include: economic forces (e.g., need for more knowledge workers; need for learners with a higher degree of cognitive strategies), social (e.g., need for stronger interpersonal skills), and physical (e.g., need for greater eye-hand coordination skills).
2. *The viewpoint taken in the creation of the OELE.* West, Farmer & Wolff (1991) discuss three viewpoints: functionalist, conflict, and critical. Of the three, a critical viewpoint is more aligned with the characteristics and assumptions of OELEs. A *critical* viewpoint involves an emphasis on "...the need for individuals to be critically aware of the choices they make and their implications" (p. 224) [see West, Farmer & Wolff (1991) for a more thorough discussion of the viewpoints]. Creating an environment where learners drive what occurs and also take on an acceptance of this responsibility, it a key characteristic in OELE design. It is important to note that the educator, or learner, may come to the OELE with another viewpoint toward learning (e.g., functionalist or conflict). To become fully immersed in an OELE, it is important to evaluate viewpoint, and work toward a more critical orientation.
3. *The structure of the learning environment.* The structure of the OELE determines the degree of definition (well-defined or ill-defined) given to the problems presented/created in the OELE. Spread across a continuum, the problems in an OELE typically range from moderately defined to ill-defined [see Jonassen (1997) for a thorough discussion of problem states]. Determining how much structure will be a part of the OELE will establish a foundation for the continued development of the OELE.
4. *The purpose in creating the OELE.* In creating a purpose, the designer of the OELE defines several fundamental elements in the design process. These include:
   - the problem being solved by the OELE (e.g., lack of transfer to novel situations; little opportunities for problem-solving; lack of argumentation from multiple perspectives, etc.).
   - the goal (both in terms of content and processes) of the OELE (e.g., argue a position using formal and informal sources of evidence; engage the scientific inquiry process, etc.)

- the type of learning the goal exhibits (ala, Gagne's (1972) type of learning outcome); and
- the function of the OELE (i.e., why do the learners need to know what is being learned).

Participants: Their Role and Characteristics. The next sub-phase in analysis involves getting to know the participants who will be taking part in the OELE. This phase in the design process also involves role and characteristic identification for the various participants (e.g., educators, learners and external experts) (West, Farmer, & Wolff, 1991). Participant analysis can be divided into several steps.

1. *Identification of who will be participating in the OELE.* Depending on the development of the OELE, the learner alone may be engaged in the learning environment. Independent study courses provide one example of how an OELE may be created with only learner participation.

Both the learner and the educator may be engaged in the OELE. While this may be considered a more "traditional" orientation to how learning occurs, the roles that the learner and educator play in an OELE are different than those traditionally played in learning context. Defining the roles played is a critical step in OELE design and is discussed in the next section.

A final consideration in terms of OELE participant identification relates to external experts. In making the decision related to the inclusion of external experts, the OELE designer seeks to answer a two-part question: will external experts play a part in the OELE, and, if so, in what capacity and how much?

2. *What role will be played by the participants in the OELE.* Making decisions regarding who will take part in the OELE are important. However, defining their roles hits at the crux of a primary assumption of OELEs: the learner taking on a greater sense of responsibility for their learning.

The roles played by those participating in the OELE are manifested in various ways. It should be noted that while it is important to define roles in the analysis phase, participant roles can, and often do, change during implementation of the OELE. One element that may drive the need for redefinition of roles is the comfort level of both the learner and educator in working in an OELE. The experience level of the learner and educator in engaging in OELEs may also affect role definition.

Three potential scenarios can be drawn related to role definition.

- *Scenario 1: The learner has almost all of the control in the OELE.* This control may include (but is not limited to) setting goals, selecting resources, and defining problems to be solved. In this scenario, the learner is very much engaged in self-directed learning.
- *Scenario 2: The learner and the educator play somewhat equal roles in the OELE.* In this instance, the educator may have some goals/objectives they consider essential for the learner to achieve as they engage in the OELE. The educator may also have pre-selected some (perhaps all) of the resources to be used in the OELE. However, the learner may have a voice in determining how or when these goals/objectives are achieved, as well as some of the resources they select for achieving those goals/objectives.
- *Scenario 3: The learner takes more of a leading role, while the educator plays a support role in the OELE (i.e., socially scaffolded learning environment).* In this instance, the educator acts as a foundation builder for the learner's engagement in the OELE. The educator works in setting the stage, bringing in the various props (i.e., resources), and creating an overall atmosphere for the OELE. The learner then acts as the driving force in what, how and when things occur within the OELE. In a face-to-face environment, this may mean that the educator establishes a structure via a syllabus, recommended readings, suggested projects, and scheduled external expert seminars. The learner then makes decisions regarding what problems to solve, and how and when to solve them.

3. *Relevant characteristics of participants.* The final element in participant analysis involves the discovery of participant characteristics which may impact their involvement in the OELE. Particular areas to attend:

- the learners prior experiences both in terms of the concepts being learned and the process being engaged in the OELE;
- learner misconceptions that may underlie learning of the concepts; and
- the educator's prior experience with the kinds of conceptual and procedural shortcomings learners experience in OELEs.

Design

Design begins after analysis has been initiated, but does not wait until it is "finished." In OELEs, an orientation toward rapid design is adopted. This is similar to the rapid prototyping model proposed by Tripp and

Bichelmeyer (1990). According to Tripp & Bichelmeyer, rapid prototyping involves the overlapping of various steps or phases in the instructional design process [see Figure 1 for an example of how this is manifested in OELE design]. This aligns the designer with the learners and educators who will be engaged in the OELE: in a problem-solving, critical thinking orientation.

The design phase in the creation of an OELE engages the designer in creating a framework for the learning environment. As in most other design models (Dick & Carey, 1997; Kemp, Morrison & Ross, 1998; Smith & Ragan, 1993; West, Farmer & Wolff, 1991), the OELE designer explores the creation of objectives or goals, helps define instructional content, and engages in strategy specification.

Defining objectives. The participant roles defined in the analysis phases will have direct implications for how (*if*) objectives are defined by the designer or by the learner. In certain implementations of OELEs, the designer may establish overarching objectives for the environment, upon which the learner elaborates, adapting them to their particular context and/or needs. This recognizes the fact that not *all* objectives or goals can be determined in OELEs a priori. Yet, the designer is typically responding to some needs or problems identified in the analysis phase. These goals and objectives may be broader than or different in scope from traditional behavioral objectives. But, typically, the designer is considering a collection of overarching goals regarding skills, processes, or strategies that are desired. In other implementations, the learner derives their own objectives based on what they hope to achieve. In either instance, the defining of the objectives usually occurs within the design phase -- either at the beginning (if established by the designer) or toward the end (if established by the learner when the OELE is implemented) of the process.

Instructional domains. The instructional domains component of the design process refers to determining the type of learning outcome(s) the learner will engage in the OELE (Gagne, 1972). Instructional designers have used a variety of taxonomies to determine the type of learning upon which the goal/objective focuses. These include: Bloom's taxonomy of cognitive outcomes (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956), a taxonomy of affective outcomes (Krathwohl, Bloom, & Masia, 1964), Simpson's plan for a taxonomy of psychomotor outcomes (Simpson, 1966-67) and Gagne's (1972) taxonomy of learning outcomes [note: see Driscoll (1994) for a more comprehensive discussion of each taxonomy]. Gagne's (1972) taxonomy is the most comprehensive, and establishes five categories of learning outcomes: verbal information, intellectual skills, cognitive strategies, attitude, and motor skills. Establishing the type of learning outcome in relation to the goal will assist the OELE designer in creating a foundation for guiding the selection of strategies later in the design process.

Instructional content. When determining the instructional content, the designer may encounter pre-determined expectations related to the learning environment. In this instance, it may become a matter of elaborating upon or refining what has been covered in the learning environment in prior implementations. This part of the design phase is important as it enables the designer to focus later efforts, especially in terms of development. It should be noted that like the establishment of objectives, who determines the instructional content is very dependent upon the roles established in analysis.

Means of instruction. Means of instruction relates to the instructional strategies and media employed in the OELE (West, Farmer, & Wolff, 1991). This sub-component of the design phase can be broken-down into three subsequent areas.

> 1. *How the content/processes are best taught/learned.* Traditionally, instructional designers have looked to specific strategies based on learning outcome to guide how to teach/assist learners in learning content and processes. As stated by Jonassen (1997), "...the most pervasive assumption of instructional design is that different learning outcomes necessitate different conditions of learning (Gagne, 1966)" (p. 66). Books have been written devoted to the topic of instructional strategies (see, for example, Gagne, 1985; Gagne & Medskar, 1996; Leshin, Pollock, & Reigeluth, 1992) and software programs have been developed to assist designers in creating instruction based on specific outcomes and strategies (see, for example, *Designer's Edge*).
>
> Given the emphasis on problem-solving and critical thinking in OELEs, how the content/processes are best taught/learned takes on an additional level of challenge when the environment is open-ended in its orientation. "Because problem-solving outcomes are not sufficiently acknowledged or articulated in the instructional-design literature, little advice about how to design problem-solving instruction is available" (Jonassen, 1997). Jonassen (1997) has proposed two instructional design models for the design of well-structured and ill-structured problems. His ill-structured problems instructional design model holds particular promise for OELEs; however, this is an area in need of further research and exploration.

2. *How to best teach/learn cognitive strategies.* The development of cognitive strategies is a critical process in OELEs. Assisting and encouraging learners in the development and refinement of cognitive strategies should be a critical part of what occurs in an OELE. This is an instructional strategy area which has been developed by Gagne' (1985). Following the basic tenets of his specified conditions for learning can greatly assist the learner as they engage in an OELE. As summarized by Driscoll (1994), these conditions include:

- describe or demonstrate the strategy;
- provide a variety of occasions for practice using the strategy; and
- provide informative feedback as to the creativity or originality of the strategy or outcome (p. 345).

3. *Selection of the delivery media.* In an OELE, the delivery media are often many and varied. Ranging from books, to people, to on-line databases, an underlying assumption in OELEs is the provision of multiple resources to help facilitate the development of multiple perspectives.

Media should not only vary in terms of the physical mode, but the content delivered via the media should also vary. This will also help facilitate the creation of multiple perspectives as the learner seeks to make meaning and establish understanding.

Evaluation methods. Evaluation is represented as an underlying process in the model depicted in Figure 1. The selection of evaluation methods as a part of the design process focuses on assessment methodologies for the instruction, as well as learner achievement. As with other components discussed in the design phase, evaluation methods are dependent upon the participant roles defined in the analysis phase of the instructional design process. If the learner is taking a lead role in the environment, evaluation may be focused solely upon self-critique measures. If the learner and educator are working on equal terms in the OELE, evaluation methods may be determined by both parties.

A critical assumption in an OELE involves learner engagement in self-monitoring and reflection as a part of involvement in the environment. This should be taken into consideration when creating evaluation methods.

Development and Implementation

The development phase, like the design phase, overlaps with several other areas in the design process, including design and implementation. As depicted in Figure 1, development and implementation almost work "hand-in-hand" in terms of creating the OELE. This overlap makes it logical to link these two phases of the process together in discussion. The ways in which the model is depicted also reflects essential element in OELE design: development is on-going, almost throughout the duration of the course.

Development and implementation place the designer in "doing" mode. At this point in the design of the OELE, the designer focuses on the creation of the various resources, and potentially tools, that the learner will need to fully engage the environment. Special considerations are discussed below.

Resources. Resources are a critical component in OELEs. In many instances, they serve as the stepping stones for the building of understanding (Hannafin et al., 1994). As such, OELE resources are not limited in terms of either their format or function. OELE resources may include people such as the educator, fellow learners, or external experts. Other resources utilized in an OELE may be electronically mediated in some fashion (e.g., video, Web sites, sound files) or be print-based in their orientation (e.g., books, journal articles, pamphlets). Still other OELE resources may be external agencies which store vast amount of information, such as academic or public libraries.

The function of OELE resources is just as varied as the formats in which they are delivered. The resources (whether selected by the learner or the educator) may serve to displace myths related to a particular topic. OELE resources may also act as factual information providers. Depending upon how it is used, the resource may also provide an incentive for the learner to look at an issue/topic from an orientation they never considered.

While providing resources in a variety of formats is an important consideration in OELEs, taking into account the message being conveyed by the resource as they are used within the implementation of the OELE is also critical. In seeking to expand the learner's orientation to multiple perspectives (a key characteristic of OELEs), OELEs demand that the resources selected represent varied orientations. While varied, they must also be "bound" together functionally in the environment in ways that converge upon a theme, yet diverge to support unique purposes and goals.

Another critical component of OELE resources relates to the actual creation of the resources. OELE resources are not limited to those which are developed in-house. Perhaps one of the biggest challenges associated with the design of OELEs comes in the gathering of the resources for the environment. While in some instances this may involve first-hand creation, often it involves seeking and gathering the resources into a readily accessible space so multiple learners have ready access to the necessary information.

On-going effort. A second element in the development and implementation phases, on-going effort, serves to illustrate the strong tie between the two areas. Certainly, implementation is an on-going effort throughout the life of the OELE. However, development work can be, and often is, an on-going effort. The types of resources needed will likely change as the problems posed by either the educator or learner emerge and grow. Continuous examination and evaluation of the resource-base is essential for assisting learners in their evolving understanding.

Evaluation

Evaluation is the process used to provide feedback to designers, enabling continual improvement of the OELE (Kemp, Morrison, & Ross, 1998). In an OELE, evaluation is a continuous process. Starting during the analysis phase of OELE design, evaluation underlies all other phases and processes associated with the creation of an OELE. Perhaps what is more critical is that the evaluation is engaged by all participants in the OELE, and in a variety of ways.

The designer engages in evaluation as a self-check to ensure that they have considered all aspects in the creation of the OELE, and to measure effectiveness of instruction, as well as the learning environment itself. The learner engages in self-evaluation and re-assessment throughout their involvement in the OELE. By cutting across the design process, the evaluation phase brings together a variety of audiences and perspectives, strengthening the further enhancement of the OELE.

Maintenance

Maintenance involves the continual upkeep of the OELE. Tessmer (1991) refers to this as sustaining use, and recommends that strategies for maintenance begin during the analysis phase. Maintenance is much like evaluation -- a continuous process throughout the life of the OELE (see Figure 1). While often discussed in terms of the long-term implementation of an OELE, maintenance could also be viewed as a process much like evaluation: ever-present and pervasive in OELE design.

OELEs are intensive yet delicate environments. As such, like the prized orchid, they require continual monitoring and care. During implementation, for instance, the instructor must be able to discern if the learner needs additional scaffolding, is running into "dead ends," or is using incompatible approaches or strategies. The learner holds primary responsibility for the learning process; yet the instructor or designer is also responsible for creating a "space" for problem-solving to occur. Through continual monitoring, the OELE can sustain growth in understanding.

Guidelines for Using the OELE Design Model

The model discussed in the previous section was generated based on key characteristics and assumptions of OELEs, as well as our work in the development of OELEs. The model does not yet have a strong empirical foundation to support it, however, it has proven to be an effective model for us in the design of our own OELEs. As caveats, we offer the following guidelines for use of the model:

- The model is descriptive in nature. It was not created to prescribe specific steps for the design of OELEs.
- The model has been used for the development of courses following the theoretical foundation of open-ended learning.
- While the model has been informally tested in face-to-face and distance formats, other OELE implementations remain unexplored.

Conclusions and Implications

The proposed model for the design of OELE courses is extensive in scope, but far from conclusive. The model discussed in this paper is based on our own experiences in the creation of OELE courses, both in face-to-face and distance formats. There exists the probability that many elements critical to the design of OELEs have been overlooked in the discussion. What is clear is that more empirical work is needed to understand if the proposed model is an accurate reflection of how to effectively and efficiently design OELEs. However, the model does provide a starting point for further exploration and discussion.

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How Do Local School Districts Formulate Educational Technology Policy?

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Abstract

This study reports on the formulation of educational technology policy in three Illinois Unit (K-12) School Districts. The major findings of the study include: (a). Educational technology policy formulation focused on collecting the objects of technology, such as computers. modems, networks, and the like, rather than viewing educational technology as a systematic process of achieving goals. (b). Active leadership from a superintendent was essential in each school district. (c) Formulation of the plans was more than an empowered committee or executive blessing. It required active participation by a superintendent. Other discussion includes a planning template was developed as insight developed from the study.

School districts are seeking ways to incorporate the latest trends of hardware and software into their classrooms. Frequently, the proponents who promote the attributes of hardware in classroom promise prosperity, school restructuring, and reformation of schools (Fiske, 1993; Reigeluth, Annelli & Otton, 1992; Stanzione & Thompson, 1993); improved attendance (Reigeluth et al., 1992); increased learning gains (Doyle & Levinson, 1993b; Fiske, 1993; Gates, 1993; Guthrie, Garms, & Pierce, 1988); improved motivation (Kendl & Liberman, 1988; Reigeluth et al., 1992); development of higher order thinking skills (Rockman, 1993); higher teacher and administrator productivity (Guthrie et al., 1988; Doyle & Levinson, 1993a, 1993b); and the "[relief of] teachers from some of the more time-consuming and inefficient aspects of their traditional role (Schlechty, 1991, p. 75).

Frequently, technology proponents and enthusiasts view technology as hardware only, and frequently microcomputers and their peripherals. However, the educational technology community views the subject as a process, such as the one these writers frequently use. "Educational technology is the systematic means of achieving stated goals." The process includes people, instructional design models, organizational and management theories and practices, research and evaluation techniques, and equipment and materials. For the purposes of this report, the terms "technology" and "educational technology" will refer to the process. When objects, such as microcomputers and their peripherals, are points of discussion, generally they will be referred to as "hardware."

Prescriptive literature describes how school districts should plan to bring hardware and software into their districts (Barkman, 1989; Burrus, 1993; Crow & Rariden, 1993; Dormant, 1992; Doyle & Levinson, 1993a, b; Dyrili & Kinnaman, 1994a, b; Kinnaman, 1991; Missouri School Boards Association, no date; See, 1992). However, little studies exist to document the actual practice, the subject of this report.

The Study

During late 1994 and early 1995, the principal investigator interviewed 36 human subjects from three Illinois Unit (K-12) School districts to investigate the nature of technology planning in their district. The subjects were from the districts' planning committees, such as the superintendent, central office administrators, principals, technology coordinators and teachers, and others who influenced the planning process. Participating school districts were selected from a population of nearly 50 Unit districts. The researchers chose to work with districts that varied in demographics. The study took its foundation from qualitative research to develop case studies to answer the research question based on Huberman and Miles (1994), Marshall and Rossman (1989), Merriam (1991), Stake (1994) and Yin (1994). The data for the study were gathered through interviews with technology planners and others who affected the planning process and inspection of relevant documents to triangulate on the facts of each case. Interview questions were developed from policy studies (Spitzer, 1992; Quinn, 1992) and general questions about the participants views and use of educational technology.

The questions were formulated and used to develop rapport with the participants and to determine reasons for hardware and software usage, as well as to help develop insights that are explored throughout the case reports (Hunt, 1995). The questions were:

1. Tell me about yourself, your background, and your current position with this school district.
2. How do you define educational technology?
3. How would you like to see emerging equipment like multimedia computers, CD-ROMs, laser discs, the information super highway, and the like used in your school district?
4. What differences do you see in the current equipment just described as compared to traditional audio visual equipment, such as overhead and film strip projectors, and audio tape players?
5. What are your sources within the district for information about technology?
6. What are your sources outside the district for technology information?
7. Do you make an effort to look for technology developments from these external sources, or is the technology news secondary?

3. How do you (individually) use technology at work and at home?

The first question was asked to learn about the educational background and educational experiences of the participants. The second question was developed because of many informal discussions with interested educators, coursework in the researcher's curriculum, participation in the educational technology planning process in his own school district, and reading about various definitions of technology and educational technology. The researcher was curious about how policy planners defined the term educational technology and whether their definition itself might impact how they developed technology policy.

The popular press repeats the promises that technology will make our lives better. The third and fourth questions were used to probe participants' perceptions of the general promises -- collected through informal discussions and reading -- that newer equipment would make students better learners and schools better places than had happened with traditional audiovisual equipment and other educational initiatives. It was the researcher's intent to probe the participants' reasons for the use of technology. From his own reading and discussions with educators and other technologists, the researcher hypothesized that technology planners would focus on hardware, technology promises, and planning literature that had no research foundation. Did they repeat and apply the mass-marketed technology promises in their own school districts or challenge and examine them? Did planning committees use prescriptive literature to develop their technology policies? The researcher hypothesized that this study would answer these questions in the affirmative.

Questions five, six, and seven were developed to investigate the sources of technology information that policy planners used to make their decisions. As stated above, much of the information flow about technology is not research-based. Is this raw, opinion-based, unfiltered, mass-market information reaching the policy planners? If so, how do they react to it?

The final question in this series was asked to seek the level of hardware and software use by the participants. Were the participants users of hardware and software or were they non-users with opinions about how hardware and software should be used?

To investigate the nature of policy planning, Spitzer's (1992) and Quinn's (1992) questions formed the basis of further inquiry. Spitzer, writing from an HPT perspective, offered ways how to design and study effective interventions in the business community. Quinn designed a major evaluation study for the Chicago Public Schools. Quinn's questions appear to be similar to those of Guba and Lincoln (1981). These sources provide the foundational questions for a complete evaluation study, but they were molded together and applied to this study to investigate the planning process in detail. The questions were:

1. What is the need for the technology policy?
2. Who is the sponsor (champion, originator)?
3. What are the expectations and commitment of the sponsor?
4. What other key decision makers in the organization have an interest in this policy?
5. What are their expectations?
6. What is the scope of the policy?
7. What are the goals of the policy?
8. What documents have been supplied to others in the organization to implement the plan?
9. What is the time frame of the project?

10. What other individuals or groups may be affected by the technology policy? What is the impact of the policy? Did they have any input on this policy? If so, in what ways?
11. What are their expectations?
12. What related policies or plans have been implemented in the organization?
13. What were the results?
14. What sources of support exist for the policy?
15. What are the constraints on the formulation of this policy?
16. What other economic, political, or cultural factors affected the formulation of this policy?
17. What individual ideas do you have about the formulation of this technology plan?

These questions were investigated through the dialog of semistructured interviews with the primary participants and by inspecting the technology policy and related school district documents. These interactions raised new questions, which led to follow-up inquiries with some participants. Furthermore, interviews with primary participants revealed issues that generated interviews with additional individuals about specific topics. Normally those individuals did not experience the full interview process; rather, the interview focused on specific details.

For example, in one participating school district, teachers were encouraged to write grants. During one interview, a primary participant mentioned how two teachers in her building wrote a technology-related grant. Those teachers were then interviewed about their grant-writing ideas and the culture of grant writing in the district.

Furthermore, at the beginning of the 1994-95 school year, new principals in one district influenced their district's planning process. They became part of the planning committee, but just before its final revision. These individuals were asked for their input since they had been previously employed by school districts that had made considerable use of hardware and software. They raised questions about why a certain computer platform was chosen and why computer networks were not part of the plan. This led the planning committee to reinvestigate and explain its platform decision and to investigate networks. It was necessary to interview these newcomers, even though their participation had been limited.

In another district, a former superintendent's influence showed in the plan, making it vital to interview him. His activities while superintendent of that school district had long-lasting impacts on its technology culture.

In two cases, additional individuals were interviewed about specific issues to corroborate what primary participants said. These individuals became secondary participants because they had little or no knowledge of the planning function, but they had influenced or been influenced by the process.

For this report, the participating school districts' names have been changed because of the promise of anonymity by the researchers. Furthermore, pseudonyms were not developed for participants. Rather, they are identified by their job titles.

The River View Technology Policy

At the time of this study, River View School District was comprised of six schools, enrolling about 4,500 students. The population was largely White (91%) and the attendance rate was high (95%), as stated on the School Report Card. The district's single high school graduated 89% of the students who enrolled as freshmen. The faculty was almost all White (a School Report Card category), very experienced, and the average teacher was paid nearly $2,500 above the state average. The school district spent about $1,000 per pupil less than the state average.

The context of technology planning and the school climate in general was flavored by a major funding issue and political fallout related to previous shifting of money between funds in the school district's budget because of failed referenda. This resulted in a slow drain of financial resources from activities that directly affected students in classrooms, such as acquisition of hardware and software, hampered technology planning, and negatively influenced school climate, in general.

Participants in this study (Superintendent, Assistant Superintendent Curriculum,Technology Coordinator, four teachers, former superintendent, two principals, and director of the public library) were the most-spirited among the three districts studied. They spoke passionately about bringing technology into their school district. Some of the teachers had strong characters, and they did not seem to accept leadership well. This appeared to cause chaos at times in technology committees activities, and a disjointed educational technology policy resulted, rather than a cohesive, insightful policy.

At the time of this study, educational technology was being considered again after a period of dormancy. A former superintendent had placed computers in the main office and into classrooms. He believed that students should use computers to learn. However, his initiative was sidetracked by the financial and public relations problems in the school district, which eventually led to his resignation. Following his departure, the district had two superintendents in two years, which put the technology initiative into a dormant state. At the time of the study, the district was still recovering from its financial problems, which had prohibited the district from updating equipment and implementing the plan. Teacher participants appeared cautiously optimistic that the plan would be implemented at some future date when the district could afford to fund it.

Technology planning in River View took place in three areas: formal planning through committee, informal communication caused by personal agendas, and independent action in each school that is funded outside the review process. The district's previous financial problems and changing two superintendents within two years affected the district's progress in many areas, especially in technology and its proposed implementation.

The previous superintendent's initial actions toward a district-wide technology initiative in the mid-1980s continued to affect the district. He purchased computers that were discontinued models at the time of the purchase, and they are still used in the elementary schools. His vision of technology applications continued to get mixed reviews by veteran teachers. His positive attitude toward technology was transferred to his technology coordinator who was the sponsor of the written plan discussed in this chapter.

Planners were concerned about purchasing up-to-date equipment, maintaining it, and purchasing replacement equipment. Other planning issues were parity and equity, training, and adoption of a platform, which itself was a small issue, but its discussion required considerable time.

In the informal mode, decisions and purchases were made and donations were received without formal review of the committee or guidance from an established procedure. The local public library donated modems to the schools so students could view the library's holdings via computer. In addition, principals attempted to secure hardware and furniture through building-wide fund raisers, while individuals influenced the expenditure of Chapter 1 funds without consultation of the committee.

The plan was constrained by the financial state of the school district, politics, the participant's views of the administration's commitment to technology, definitions of educational technology, and communication of the committee with its community.

The Orchard Heights Technology Policy

At the time of this study, Orchard Heights School District was comprised of 15 schools, enrolling about 8,500 students. The population was 60% White, 19% Black, and 20% Hispanic; it had a 93% attendance rate. The high school graduated 82% of the seniors who enrolled as freshman. The faculty was largely White (91%), very experienced, and the average teacher was paid nearly $2,000 above the state average. The school district spent about $1,000 per pupil less than the state average.

The participants in this study (Superintendent, Technology Coordinator, four principals, nine teachers, and Mayor's assistant) expressed commitment to technology applications in their school district. Although the researcher did not see the lively spirit as in the previous school district, the participants spoke with conviction of their ideas and trust in the technology planning process and the potential of technology in their school district.

During the study the school district passed a referendum to finance its technology initiative. The participants were convinced that the district did not have financial resources to fund a technology initiative because the state had placed a cap on annual property tax increases in the school district's county at a 5% increase or the actual cost of living increase, whichever was lower. The voters dispelled that concern.

A core of technology planners -- led by the superintendent, technology coordinator, and technology committee co-chair -- formed a nucleus of policy makers in the district. However, some planners identified other influential faculty members as important players in the plan's formulation.

Before the formulation of the plan that was the subject of this study, the district's efforts in technology planning and implementation were irregular. Planning and equipment acquisitions were made by a district computer committee in various forms. Three grants from the regional telephone company created disparity because it focused only three of the district's schools

The plan that was investigated in this study contained philosophical and visionary statements, student goals and hardware requests. Essentially the plan attempted to level individual and school initiatives that were encouraged by administration because the school district did not provide financing for a consistent, district-wide initiative.

The views of the technology, such as technology is an enhancement, affected the formulation of the plan. Participants appeared to view computer-based technologies in differently from traditional equipment like movie and slide projectors.

The committee that formulated the plan was composed of teachers from schools and administrators. The committee focused on acquiring equipment to enhance education. Other planning issues the committee considered were parity, networking, and staff development.

The high school principal appeared to influence the contents of the final plan as he sent detailed letters to the planning committee's sponsors. He was successful in getting networks and mobile computer labs for his school into the plan. The principal's influence was noted by participant's in all levels of the planning committee.

The planning process was constrained by the district's lack of defined leadership because no individual or group appeared to want to take the lead on planning issues. The long-term culture of freedom produced pockets of hardware that the plan attempted to acquire and distribute to all schools. Politics, especially those associated with the principal's push to make his school the technology showcase, constrained formulation. The plan was limited by the committee's perceived view of community commitment. They stated that the they thought the community would not fully support a technology initiative to provide full technology opportunities for children. In addition, the plan was limited by the lack of communication with the school community.

During this study, the school district was working with the city to establish a city-wide network with other public entities and private university in the city. This network was to have been the backbone for large-group learning in the Orchard Heights schools.

The State Park Technology Plan

At the time of this study, State Park School District was comprised of 14 schools, enrolling about 5,500 students. The student population was the most diverse of the three school districts in this study. Thirty-seven percent of students were White, 57% were Black, and 5% were Hispanic. Over half of the students were low income, but the attendance rate was 92%. The high school graduated only 67% of the seniors who enrolled as freshmen. The faculty was 83% White, 16% Black, and 1% Hispanic; averaged nearly 15 years of experience; and were paid about $1,000 below the state average. The school district spent about $100 per pupil less than the state average. The current superintendent noted that one of the district's main problems was that the district had a high mobility rate, in that about one-third of the students in the school district either enrolled or left the district during each school year. The Assistant Superintendent for Business Affairs related that the district was poor financially and that it received most of its operating revenue from state (50%) and federal (17%) sources.

Before the current plan, the district's technology initiatives were limited to labs in each attendance center. The plan that was the subject of this study was sponsored by a superintendent who, as a new employee in the school district, brought high energy, new ideas, and a technology vision and experience to the district. Because of his task of reorganizing and re-energizing the school district, he turned to an outside consultant -- IBM Corporation -- for assistance. An IBM facilitator led a district planning committee through a two-day planning session based on an IBM process, known as a metaplan, to develop the plan. Before the actual planning session, the planning committee visited schools that were thought to be in advanced stages of technology implementation; counted the computers in their own district; and surveyed their district's teachers on computers, although it is unknown if the survey results actually were used during planning. During the session, the planners developed a mission statement, identified problems and solutions, and proposed an action plan in a dynamic and positive group interaction. The plan was constrained by the accelerated planning process and communication with the school community.

The plan was developed in 1992 and essentially placed on the shelf, because of funding. Planners returned to their regular duties, and the sponsor retired from the school district and education on June 30, 1993.

Cross-Case Comparison

In all three districts, nearly every participant gave definitions or descriptions of educational technology that were related to what Saettler (1990) called the "physical science approach" (p. 5).

Participants in River View called technology "a tool" or gave examples of hardware and software. In Orchard Heights, the "enhancement" view was similar to River View's tool description. Examples of hardware and software were given in State Park. The Orchard Heights superintendent was the only participant to give a process-oriented definition:

> It's far more than the hardware and software. I believe that it's almost the process of exploration. Technology is really a step-by-step process of problem solving. . . . It's not necessarily what it is, but what it can do.

Furthermore the following points can be extracted from the study.

1. Educational technology policy formulation focused on collecting the objects of technology, such as computers, modems, networks, and the like, rather than viewing educational technology as a systematic process of achieving goals.
2. Active leadership from a superintendent was essential in each school district. Formulation of the plans was more than an empowered committee or executive blessing. It required active participation by a superintendent.
3. School districts developed educational technology policies regardless of their financial state.
4. Educational technology policy formulation occurred without regard for student demographics.
5. Applied technology or technology education -- including electronics, robotics, video production, industrial technology and metals technology -- was part of educational technology policy formulation in two of the three school districts.
6. While planning focused on the objects of educational technology, planners took little action on other elements of educational technology planning, such as staff development, finance, evaluation, and school cultural issues.
7. Technology planners did little to communicate aspects of their educational technology plan to their school communities.
8. Educational technology policy was a political process. Whether it was new superintendent pushing his technology agenda or a teacher influencing a computer purchase, politics were part of the process.
9. The planning committees were not representative of the school community.

Technology Planning Web

From listening to the technology planners from the three school districts describe the technology-related issues, examining their documents, and studying their plans, the researcher observed that some of their planning ideas had omissions, such as detailed plans for staff development, finances, evaluation, and school culture issues. From this research he developed a planning template focused on the planning aspects of educational technology.

The flow of a technology initiative starts with a vision. A single goal or a series of goals should flow from this vision. Learning activities are then developed and implemented. These events are followed by an evaluation, either formative or summative. In a systems approach, evaluation is followed by a recycling component to revise portions of the learning experience that do not meet the evaluation criteria. Figure 1 shows the general flow of a technology initiative.

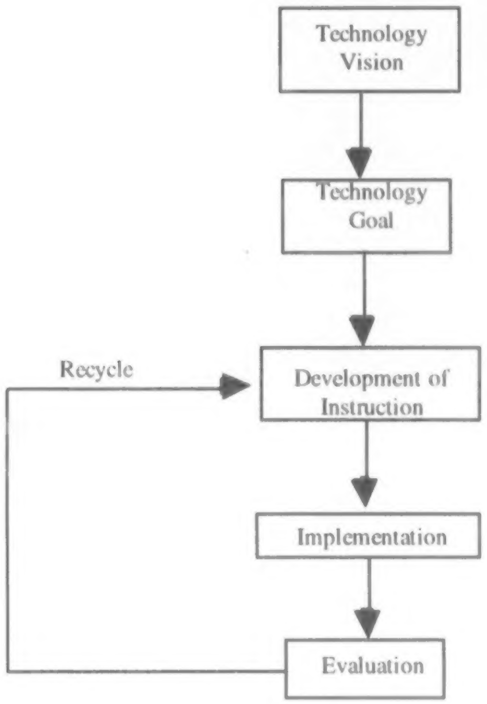
Technology Vision
Technology Goal
Recycle
Development of Instruction
Implementation
Evaluation

Figure 1. Flow of a Technology Initiative

Using a systems approach and adding the omissions observed in the participating school districts' planning activities, the researcher proposes a technology planning template that would be used at the goal and development steps. It is called the "Technology Planning Web" and is shown in Figure 2. The components of the web are evaluation protocol, staff development, hardware, finances, research and development, physical infrastructure, and political/cultural infrastructure. Each component offers its own challenges and systematic design solutions. Most important is that each component needs detailed planning and not just a mere mention in the educational technology policy.

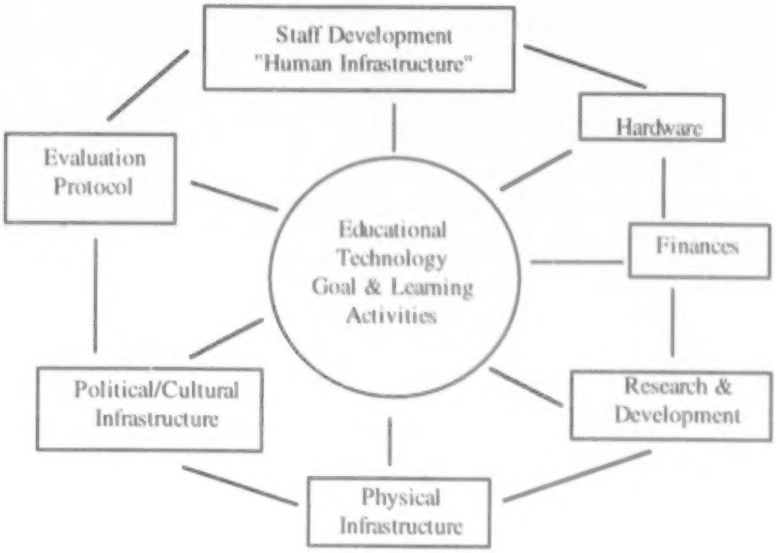

Figure 2. Technology Planning Web

The web can be used by a school district committee to consider how to address technology planning. This web would be applied after the planning committee has constructed a mission, vision, or philosophy statement. Goals should be derivatives of the declarations of the committee's preferred future state of the school district. As each technology goal is composed, the web should be used to remind the planning committee of other issues that exist for that goal. Each goal should have its own web so that a complete plan will have a detailed web for each goal. Specific learning activities then can flow from the goal statements, such as those related to keyboarding, group learning, or literacy issues.

One omission that was noted in the technology planning of the three school districts in the study was that no evaluation protocol existed for the plans. The participants offered various measurements of success: purchasing all of the equipment in the plan, use of the equipment, and integration into the classroom. However, these were not aligned with their preferred future states. Only a few participants mentioned impacting the learning of children as a success factor.

Many instructional design models specify writing the evaluation protocol at the time the goal statement is written (e.g. Jonassen, 1988). One distinct advantage of writing the evaluation at that time is that the human energy required to reach consensus about a goal can be used immediately to construct the evaluation protocol. The procedure is continuous and the evaluation is developed in the same context as the goal and not at some later time by another committee that wonders about the origin or reason for the goal statement.

For technology planning, Herman (1994) suggests that evaluations should be based on quantitative and qualitative data. She notes that educational technology initiatives are nearly impossible to evaluate when teachers are encouraged to adapt the technology to their own classrooms. Doyle and Levinson (1993b) and Dyrli and Kinnaman (1994a) advocate that planners develop curriculum activities that can be uniformly applied across the district, not adapted for individual classrooms.

If a technology goal states, "Students will be engaged learners," the next immediate question should be, "How would we know when we have engaged learners?" The committee could then write the necessary protocols that could be revisited at some future date to check on progress toward reaching that goal. At some future date, when the school district writes its annual report, "We are a community of engaged learners," then it could describe the justification for the statement. Once the goal and evaluation protocol are developed other issues become evident that are not necessarily linear, but are interrelated as in a web.

Three elements of the web are inanimate: hardware, physical infrastructure, and finances. Once the goal and evaluation protocol are developed, the committee should make recommendations for hardware, its related software, and necessary wires -- the physical infrastructure -- to make it operate. The infrastructure needed could be as basic as extra electrical outlets in a room to power a computer or as sophisticated as a district-wide fiber-optic system. The Missouri School Boards Association (no date) suggests that planners should survey hardware possibilities early in technology planning. However, many instructional design models specify hardware requirements later in the planning (e.g., Heinich, Molenda, & Russell, 1989). Hardware should be selected in accordance with the design models.

The hardware element in the web should account for obsolete equipment. How will the district decommission old equipment? Will equipment be placed in other places in the school or district when it is replace or should it be disposed of when it is obsolete for its original purpose?

Finances are another non-human element in the web. Why develop a sophisticated technology plan when funds are not available to implement it? Certainly, the sponsor of the State Park technology policy should be congratulated for energizing the planning activity, but money did not exist and little hope existed that it would. The planning facilitator stated that the process she used helped communications within the group -- a powerful and positive side-effect of such a group effort -- but with the funding issues in the school district, why even start building a plan with no attempt to search for funds? An attempt to assure funds from regular budget lines, partnerships, or referenda, should be occurring at least in parallel with a district planning process.

Human issues of politics/culture and staff development are also key elements of the web. How will a district address these issues? Burrus (1993) stated that "technology changes everything" (p. 18). Whether the district employs a sophisticated planning process or merely transplants hardware in a library/media center, the existing school culture is threatened. How will districts focus the benefits of educational technology and restrain those that may be detrimental to learning? Districts need to forecast these changes and be attentive to them, if they observe what Burrus claims, we have no choice.

In the political arena, this study noted that educational technology policy formulation is a political process. The leadership of technology planning must recognize that individuals or schools will attempt to influence the plan to benefit the particular agenda. The leadership must be ready to act to keep the process focused on reaching a school district vision and be ready to soothe bruised egos, reward behavior parallel to reaching district goals, and prod lagging planning activities.

Dormant (1992) identifies problems in causing change in an organization. Culture and leadership are two major issues that cause or stop change. She quotes Shein's definition of culture as "a pattern of basic assumptions -- invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration" (p. 173). Simply stated, culture is the behaviors and beliefs that exist in an organization. Any change is an assault on those beliefs. Some will "buy-in" to the change quickly while others will be "middle adopters" or "laggards" (Dormant, 1992, p.181).

As part of the cultural change, show that the technology plan is important to the district. Organize a parade; set off metaphorical fireworks or real ones, if affordable; have a rally; or merely have the band play. Show everybody in the school community the importance of the technology plan. Sell the sizzle, as Burrus (1993) stated, and be prepared to deliver the thick, juicy steak of student learning and goal achievement.

Communication is important in this cultural change. The committee should institute a means of communication with the constituent community. Committee members who serve as technology hubs is one avenue of communications. They should request time in faculty meeting to explain planning updates to teachers. Staff and community newsletters, brochures, and press releases are other means of communications. Planning committees should exploit these means of informing the greater school community of progress in planning.

Another human element is staff development or "human infrastructure." What good is a fully-funded technology initiative with all the physical hardware and wire infrastructure in place, if the staff and students have not been trained in how to use for its desired purpose? Burrus states (1993), "Upgrade technology and upgrade people. The two must go together. . . . If [people] don't have the necessary skills then even the most sophisticated technology is only a blunt instrument" (p. 107).

Burrus (1993) relates a looming problem that accompanies the lack of employee training.

> Talk about death spirals. Add new technology at great expense but without upgrading the people who will use it. When the technology doesn't work right, dispose of the people. The problem persists, eliminate more people. No solution in sight, scrap the new technology. (pp. 107-108)

While education depends heavily on people to deliver its services, the business problem Burrus explains has a parallel in education; that is, when employees and students are not trained and consequently do not use the equipment, blamed is assigned, and funding is diverted to other projects.

One component of staff development is related to the organization's reward system. Burrus (1993) listed many short, seemingly trite, sayings about causing change, but one is important for this circumstance. "We get the behavior we reward" (p. 179). Burrus maintains that the quickest way to get a change in culture is to change the reward system. Reward those employees who first adopt what the new culture of technology offers. As other employees see that the new way is rewarded, they will begin to work toward those goals, too, or they may leave the organization, if the goals are contrary to their personal beliefs.

Gilbert (1978) described the importance of reward systems many years ago. He divided them into two areas: "money and other things" (p. 309). Other things are "recognition for good work, patting them on the back, and presenting medals," among many possibilities. Gilbert advocated using money to reward.

In educational organizations the reward system is typically in the form of recognition. It could be in the form of a certificate presented in a large group meeting; a verbal commendation in front of a large group; or a letter of commendation. The achieved goals should become part of individual employee evaluations, although this is a personnel issue and rarely seen by anyone besides the teacher and the evaluator.

The final element in the web is research and development (R&D). The researcher considers the R&D element of technology planning vital in part of the planning process. With the high costs of hardware, software and time, (e.g., U.S. Congress, 1988), planning should have a speed regulator -- the R&D section. R&D should be directed by the district's technology specialist and funded as part of the technology budget.

The R&D component has at least two branches. One of them deals directly with attainment of goals, and the second tests new products. If the planning process centers on literacy issues, why change from current practices, if the learning gains from educational technology are minimal and there is no other measurable advantage? For example, does the software program "Mathblaster" contribute to student growth in math facts better than traditional means of drill and practice activities -- such as flash cards and chalkboard contests? If R&D finds that 90% of third graders know 90% of their required math facts after using "Mathblaster" three times a week for 20 minutes each session and the students are achieving at the 75% level through traditional means, this finding needs to be explained to teachers through many sources, especially staff development activities and internal communications. Advantages of using this software need to be identified and expressed to the teachers. Furthermore, the reward and employee evaluation systems needs to encourage "Mathblaster's" use. Additionally R&D could assist curriculum adoption committees as they test, develop, and evaluate prototypes; and assist in curriculum development activities.

In the second branch, new hardware and software are tested. As new hardware is introduced to the market, the R&D section should acquire it and develop tests to see if it improves achievement in stated goals, such as with the previous "Mathblaster" example, and to find new equipment's operating envelope. This important step identifies the unit's actual operation, not what the sales person or specifications predict. Buy one, put it in a common area for students and staff to use, and let them help determine its actual operating characteristics. This could save embarrassment to the district when committing money to buying many pieces or a system for the district, only later to find out it does not operate like it did in the demonstrations or as the specifications promised.

Educational technology planning, as any other planning process, is not a simple, linear function. The Technology Planning Web is a research-based template, founded on the insights developed during this study. By using the web, planners can focus on goals and support those goals with full consideration of staff development, hardware, finances, R&D, physical infrastructure, political and cultural infrastructure, and evaluation.

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Effects of Inductive Multimedia Programs Including Graphs on Creation of Linear Function and Variable Conceptualization

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Abstract

This study examined the effects of an inductive multimedia program, including graphs, on subjects' ability to create linear functions and conceptualize variables from word problems. The subjects were 98 undergraduate students, enrolled in two sections of a computer literacy course at a large southwestern university. Students' achievements were assessed via 12-item, short answer, pre- and posttests, which were parallel to the instructional themes stated in the treatment programs.

Students were randomly assigned to one of two treatment groups to view a version of a self-paced program. Treatment 1, the inductive table-only program, included tables in addition to other multimedia elements and was developed based on many instructional strategies including inquiry inductive learning strategy. Treatment 2, the inductive table-and-graph program, included both tables and graphs and was identical to the first version in all respects except for the addition of the graph visuals and graph-related text.

Students, regardless of treatment, scored significantly higher on posttest than pretest on both function construction and variable conceptualization. These results may have been influenced by instructional strategies used in the treatments including: inquiry mathematical thinking, schema training, linked representational systems, and the coordinate graph tutorial teaching.

Students receiving instructions via the inductive table-and-graph program scored significantly higher on function construction section of the posttest than did students receiving the table-only treatment. This result is consistent with prepositions recognizing the conceptual richness of visuals, specifically the coordinate graph, in mathematics education learning.

Results from the present study suggest the use of inductive multimedia programs treatments that include many strategies including inquiry learning from data, tutorial, schema, and core representational systems for the problem of translation, specifically creation of linear function. The data specifically suggest that the inductive multimedia programs that include the coordinate graph tutorial strategy in their construction have a significant effect on the function construction tasks.

Introduction

National reports (Dossey, Mullis, Lindquist, & Chambers, 1988; Mullis, 1994; Mullis, Dossey, Owen, & Philips 1993) indicate that many students do not understand mathematical concepts and skills taught in schools. Mathematics proficiency is crucial for the individual pursuing higher education (National Research Council, 1989) and critical to the creation of an informed citizenry and economically competitive society (Anderson et al., 1994).

This lack of mathematics understanding, in algebra for example, forces students to memorize algebraic rules and procedures. Therefore, many students think algebra is simply rule-based memorization (Brown et al. 1988; Kieran, 1992). As a result, students are often unable to apply basic algebraic and geometric concepts to problem solving (Brown et al.). A number of studies indicate that, even in ordinary relational word problems, students have major difficulty generating equations that represent relationships (English & Warren, 1995; Chaiklin, 1989; Clement, 1982; Herscovics, 1989; Lewis & Mayer, 1987; MacGregor & Stacy, 1993; Mayer, 1982).

Researchers have pointed out that instruction in generating linear function needs an approach that considers students' general reasoning processes (English & Warren, 1994) and accounts for conceptual errors in problem translation (Kaput & Simes-Knight, 1983). In addition, instruction must include linked multimedia presentation, emphasizing visual algebraic process representations, including tables, patterns, and graphs (Kaput, 1992; Kosslyn, 1980). To address the difficulty students have in learning how to generate linear functions (or equations) from relational word problems, the following offers a two-part solution. Using linked representational media (multimedia programs), mathematics Computer-Based Instruction (CBI) should stress (1) inductive problem-solving strategies or scientific heuristics (for example, by working backwards, working inductively, or applying algebraic thinking to data) (DeMarois, McGowen, & Whitkanack, 1996; Polya, 1954) and, most importantly, (2) the teaching of the language of mathematics and math visuals (graphs) (Esty, 1992; Kaput, 1992; Bell & Janvier, 1981). Based on an inductive multimedia program developed according to the above approach, this study sought to determine how visuals (table and graph) affect students' creation of linear function construction and variable conceptualization from relational word problems.

Justification

In today's work environment, the ability to think critically, to communicate mathematical ideas, and to develop problem-solving strategies is essential (Smith, 1994). Furthermore, while building toward a career, research indicates that a strong relationship exists between mathematical skills and success in college, regardless of major (Waits & Demana, 1988). However, despite the proven short- and long-term value of math skills, student underpreparedness in mathematics is a continuing and growing problem in higher education (Berenson, Best, Stiff, & Wasik, 1990). In algebraic problem-solving situations, students find algebraic applications difficult. Collegiate mathematics education research (Clement, 1982; Lewis & Mayer, 1987; Lochhead & Mestre, 1988; Mayer, 1982; Wollman, 1983) indicates that most students cannot, in fact, translate rational word problems into simple linear functions.

Several researchers (Bishop, 1989; Clements, 1982; Janvier; 1987) have encouraged research in the exploration, investigation, and curriculum implications of graphical and tabular representations of knowledge. According to Dugdale, Thompson, Harvey, Demana, Waits, Kieran, McConnell, and Christmas (1995), a graphical representation "can reveal insights into the problem situation that are not readily revealed by symbol manipulation alone" (p. 330). On the other hand, studies (Carpenter, Corbit, Kepner, Lindquist, & Reys, 1981; Goldenberg, Lewis, & O'Keefe, 1992; Kerslake, 1981; Monk, 1992) indicate that graphical presentation adds its own ambiguity to the learner's syntactic translation problem. Despite the ambiguous role of graphical presentations in problem solving, various researchers support the use of visuals: as mnemonic tools (Atkinson, 1975; Lewis, 1989; Winn, Tian-Zhu, & Schill, 1991), as gestalt-producing mental processors (Skemp, 1989), and as mathematics language (Esty, 1992; Janvier, 1987; Kaput, 1989). Graphs, for example, enable problem solving because a graph allows one to view a single graphical entity instead of a binary quantitative relationship (Kaput, 1989), which is, by definition, a more complex matrix from which to draw a solution.

Kosslyn (1994) has shown that human visual perception and cognition have strengths and limitations, and their measures depend on both the quality of visuals displayed and the adequate usage of those visuals. With their visual (graphic) and authoring programs, low-cost microcomputers have removed many visual cognitive obstacles in mathematics teaching, as in their numerous other applications developed to aid cognition. Computers may help us to use visuals more adequately. For example, graphs can be made even more cognitively engaging via animated displays and linked explanations. Authoring programs facilitate development of materials that allow visual learning as well as inductive reasoning. Computers can be used to develop visuals and support reasoning processes, as well as to measure whether, based on a set of dependent variables, visual treatments differ on average.

Although researchers have not taken up his mandate, Clements (1982), a recognized expert in mathematics education, has concluded that despite the fact that clear guidelines for the use of visuals in classroom practice have not yet emerged, "there should not be a reduction in the amount of research which is aimed at achieving this end" (p. 36). Clements stresses that "Mathematics educators need to develop better instruments for assessing the role of visual imagery in mathematics learning" (p. 36). The classroom application of computer-supported or computer-generated graphs and of graphic language are important and viable areas of research in mathematics teaching (Bell & Janvier, 1981; Bishop, 1989; Drefus & Eisenberg, 1987; Eisenberg & Drefus, 1991; Lesh, 1987). Currently, however, little research exists on (1) combined visual effects, (2) inductive software program training, (3) strengths and limitations regarding the order of visual presentation, or (4) any combination of the above. Since the use of visual thinking in mathematics learning is controversial, multivariate research considering many factors may help clarify the role or roles of visuals in problem solving.

The present study considers a multivariate approach to the role of visuals in problem solving based on the need that exists for inductive algebraic multimedia software programs that strongly support the growing interest in the use of visuals in mathematics-based cognitive processes. The graphical presentation and construction capabilities of software programming currently offer the most practical way of producing and using quality visuals. The mere inclusion of graphs is not enough, however; programs should also address the language of graphs and provide solutions to students' graphical misconceptions in a dialogue with learners. Algebraic software programs should consider graphical cognitive obstacles, graph language, and the order of visual presentations. The present study looks for a strong possible visual effect via the combination of tables and graphs with graph language in an inductive multimedia program to improve linear function construction and conceptualization of variables.

Hypotheses

Hypothesis 1: Students receiving instructions via either software program will score higher on the posttest than on the pretest in both areas: linear function and variable conceptualization.

Hypothesis 2: Students receiving instructions via the inductive table-and-graph program will score higher on the posttest in both areas than will students receiving the table-only treatment.

Subjects

The subjects were 98 undergraduate students enrolled in one of two sections of EMC 321, Computer Literacy, offered by the College of Education during the Fall 1997 semester. Subjects ranged in age from 18 to 25 years.

Treatments

Two inductive multimedia programs served as the instructional treatments for this study. Both self-paced treatments were developed by the author using Authorware 3.0 via Macintosh. Both programs, *InductiveThinker Table* and *InductiveThinker Table & Graph*, had two lessons. Lesson one contained information about the input, output, and independent and dependent variables. Lesson two included information about the rate of change (or the slope of the function) and linear function creation. Some screens were added to *InductiveThinker Table* to construct *InductiveThinker Table & Graph*. The pace was user controlled and subjects had the ability to navigate between pages, sections, or lessons and could exit the program at any time.

The instructional treatments were evaluated via two types of formative evaluation procedures described by Dick and Carey (1985): one-to-one and small-group. After a review by three College of Education instructors, which suggested a major change regarding method, level of control, and content, the treatments were piloted using seven students similar to the target population who were unfamiliar with the programs.

Instruments

Two instruments were used to collect data:

Instrument 1: As one of the primary measures, the first instrument was a 12-item pretest administered to both groups at the beginning of the data collection. Test items were in short-answer form (both English and algebraic) and were parallel to the practice items contained in *InductiveThinker Table*, the first program. The pretest items measured student achievement on the instructional themes specifically stated in the *InductiveThinker Table* program.

Instrument 2: Another of the primary measures, the second instrument was a 12-item posttest administered to both groups at the end of the treatment. Test items were again in short-answer form (both English and algebraic) and were parallel to both the items contained in the pretest and to the practice items contained in *InductiveThinker Table*, the first program. The first six questions of both the pretest and the posttest paralleled the classic student-professor example, to some extent. The last six items of both the pretest and the posttest were related to the conceptualization of variables.

Procedures

Subjects were randomly assigned to two treatment groups. Both treatment programs were delivered via Macintosh computers in Farmer 214, a computer lab in the College of Education. Throughout the self-administration of the program, subjects spent as much time as they desired on any portion of the program. Subjects from each group viewed the treatments individually, under the same physical conditions, and all received extra credit for participating in the study. Subjects chose their own participation times from a variety of times offered and were evaluated via a pretest before the treatment and a posttest upon completion of the programs.

Design

This study used a Pretest-Posttest Control Group design. A pretest of the dependent variable was administered to both groups. Then, the control group received an inductive table treatment, while the experimental group received a manipulated treatment (Inductive Table and Graph). Finally, both groups were posttested. The treatment forms were A versus A+B.

Validity of the Research Design

The Pretest-Posttest Control Group design was selected because the subjects had a variety of mathematical backgrounds and came from different disciplines. The combination of (1) random assignment, (2) the presence of a pretest, (3) the presence of a control group, and (4) the short data collection period controls for threats to internal validity, such as statistical regression, mortality, maturation, history, testing, and instrumentation.

Statistical Analysis

Multiple Analysis of Covariance (MANCOVA) was used to determine whether there existed a significant difference between the posttest scores of subjects who received Inductive Table instruction and those who received Inductive Table and Graph instruction.

Limitations

The sample for this study was selected from two sections of an undergraduate course offered by the College of Education at Arizona State University. The three-credit course was offered during the Fall 1997 semester. Selection was based on the willingness of instructors to facilitate the study and students to participate in the study. In addition, only undergraduates enrolled for credit (rather than audit) were selected. Subjects were randomly assigned to one of two groups.

Significance of the Study

Significantly higher test scores from those students who received the Inductive Table and Graph instruction (1) would lead to a useful guideline for computer-based classroom and at-a-distance algebraic practices and (2) would provide positive support that, when they are taught and used properly, graphical presentations offer a powerful holistic visual aid to the complex abstraction of mathematics. In addition, this study may introduce support for the role of graphs in theories of imagery.

Results

The purpose of this study was to determine the effects of an inductive multimedia program including graphs and tables on subjects' ability to create linear functions and construct variables from word problems. Subjects viewed one of two self-paced inductive multimedia programs. The first program, *InductiveThinker Table*, included tables in addition to other elements (e.g., animation). The second version of the program, *InductiveThinker Table & Graph*, included both tables and graphs. This program was identical to the first version in all respects except for the addition of the graph visuals and graph-related text.

Demographic Data

The data collection began with 101 undergraduate students enrolled in two sections of Computer Literacy, in a large South western university. The scores of three students were discarded because they did not finish the posttest. Of the remaining 98 students, 69 were females and 29 were males (70% and 30% respectively) with mean age of 22.6 years for both males and females. Thirty-six percent of students reported majors in Communication or Journalism, 23% in education, 10% in justice studies, and 31% others.

Subjects were randomly assigned to the treatments and the size of the sample was not fixed, resulting in groups of different sizes. The size of the sample for treatment 1, *Inductive Thinker Table*, was 47 subjects and for treatment 2, *Inductive Thinker Table and Graph*, 51 subjects.

A split-half (odd-even) reliability test was conducted on the 12 items pretest and posttest to assess linear function construction and variable conceptualization. Coefficient alphas were computed to obtain internal consistency estimates of reliability for these two scales. The alphas for the pretest and posttest scales were .70 and .61 respectively. The tests measured the intended content areas: Function construction and variable conceptualization. Pretest and posttest items were parallel to the practice items contained within the instructional programs and were short-answer and multiple choice in format.

Subjects were schedule to spent one hour on treatments. However, the lab observations indicated that subjects spent less than one hour with the programs. Subjects often came late and rushed through to finish the programs in order to catch their next class. Most students came during the lab rush-hour, often during times when they were supposed to be in their computer literacy class. Many subjects were bored and tired at the end of the treatments.

Data Analysis

Two hypotheses were considered. The first involved examining whether the mean difference between pretest and posttest scores on two levels (function construction and variable conceptualization) were significantly different from zero. One-way, repeated-measure, analysis of variance (ANOVA) was used to measure mean differences between pretest and posttest scores, first, of function construction and second, of variable conceptualization.

The second hypothesis involved examining whether the posttest adjusted means on a set of dependent variables (function creation and variable conceptualization) varied significantly across the two factors (Table and Table & Graph treatments). A multivariate analysis of covariance (MANCOVA) was used to determine whether groups differed on the dependent variables. The Statistical Package for the Social Sciences (SPSS) was selected for use in this study. An alpha level of .05 was used for all statistical tests.

Hypothesis 1

Students receiving instructions via either software program will score higher on the posttest than on the pretest in both areas: linear function and variable conceptualization.

A one-way repeated-measure ANOVA was conducted with the factor being either treatment and the dependent variable being the pretest and posttest scores for function construction. The means, highest possible scores, number of subjects, and standard deviations of scores are presented in Table 1. The results for the ANOVA showed a significant treatment effect on function construction regardless of kind of effect, Wliks's Lambda = .457, $\underline{F}(1, 97) = 115.27$, $\underline{p} < .001$, multivariate $\underline{d}$ (Eta Squared) = .543.

Table 1. Means, Highest Possible Score, Number of Subjects, and Standard Deviations for Function Construction Scores

Dependent Variable	M	Highest Score	N	SD
Pretest	1.97	6.00	98	1.79
Posttest	4.11	6.00	98	1.52

A follow-up pairwise comparison, univariate test was conducted. The results confirmed the Multivariate test indicating that the posttest mean ($\underline{M} = 4.11$, SD = 1.52) was significantly greater than the pretest mean ($\underline{M}$ 1.97, $\underline{SD} = 1.79$), $\underline{t}\,(97) = 10.74$, $\underline{p} < 0.008$.

Another one-way repeated-measure ANOVA was conducted with the factor being treatment and the dependent variable this time being the pretest and posttest scores for variable conceptualization. The means, highest possible score, number of subjects, and standard deviations of scores are presented in Table 2. The results for the ANOVA showed a significant treatment effect on variable conceptualization regardless of kind of effect, Wliks's Lambda = .622, $\underline{F}\,(1, 97) = 58.84$, $\underline{p} < .001$, multivariate $\underline{d}$ (Eta Squared) = .378.

Table 2. Means, Highest Score, Number of Subjects, and Standard Deviations for Variable Conceptualization Scores

Dependent Variable	M	Highest Score	N	SD
Pretest	4.06	6.00	98	1.21
Posttest	5.01	6.00	98	0.83

A follow-up pairwise comparison, univariate test was conducted. The results confirmed the Multivariate test indicating that the posttest mean ($\underline{M} = 5.01$, SD = .83) was significantly greater than the pretest mean ($\underline{M} = 4.06$, $\underline{SD} = 1.21$), $\underline{t}\,(97) = 7.68$, $\underline{p} < .001$.

Hypothesis 2

Students receiving instructions via the inductive table-and-graph program will score higher on the posttest in both areas than will students receiving the table-only treatment.

A MANCOVA with two dependent variables and two covariates was conducted. The independent variable, instructional treatment, included two levels: inductive table and inductive table and graph programs. The dependent variable, posttest scores, also included two levels: function construction and variable conceptualization. The covariates were pretest scores on both function construction and variable conceptualizations.

The MANCOVA indicated that the adjusted population mean vectors (posttest scores) were significantly different among the groups at the .05 level ($F = 4.77$, $p < .001$). The MANCOVA's first assumption (check to see that there is significance relationship between the dependent variables and the covariates) was verified. Sample size justified using two covariates ($C < 8$, where C is the number of covariates). Tables 3 and 4 show the means and adjusted means for treatments of the set of dependent variables and the means of pretests.

Table 3. Means of posttests and pretests for Function Construction

Treatment	Observed M	Adjusted M
Inductive Table (Posttest)	3.70	3.69
Inductive Table & Graph (Posttest)	4.50	4.51
Inductive Table (Pretest)	1.99	-----
Inductive Table & Graph (Pretest)	1.97	-----

Table 4. Means of posttests and pretests for Variable Conceptualization

Treatment	Observed M	Adjusted M
Inductive Table (Posttest)	4.83	4.89
Inductive Table & Graph (Posttest)	5.12	5.12
Inductive Table (Pretest)	4.03	-----
Inductive Table & Graph (Pretest)	4.67	-----

A separate analysis of covariance was done on each dependent variable. The probability indicated that only the function construction variable was significant at the level .05 (Table 5). The power on the variable conceptualization was .31. Probability of students receiving instructions via either treatment and score significantly different on the posttest in variable conceptualization is very low. Low power indicates a low probability of rejecting the null hypothesis.

Table 5. Analysis of Covariance on Dependent Variables

VARIABLE	MS	F	p	Power
Function Creation	16.38	8.3	.005	.81
Variable Conceptualization	1.33	2.2	.139	.31

The multivariate test for the homogeneity of the regression hyperplanes was not significant at the .05 level ($F = .237$, $p < .917$) indicating that the assumption of homogeneity was quite tenable. The multivariate F, corresponding to Wilk's lambda, indicated that there is a significant difference between the set of dependent and the set of covariates at the .05 level ($F = 6.367$, $p < .001$). Table 6 indicates that 22.83% of the within variability on variable function construction is accounted for by two covariates, pretest function construction and variable conceptualization.

Table 6. Univariate Tests for Relationship Between Dependent Variables and Covariates

VARIABLE	SS	MS	F	P
Function Creation	22.83	11.42	5.8	.004
Variable Conceptualization	8.68	4.34	7.3	.001

The Bryant-Paulson procedure was conducted because of the possibility of measurement error on the covariant of low or questionable reliability. The question was whether there was a significant difference between the adjusted means on function construction for the groups. Results again indicated a significant difference, Hotelling Value = .0001, interpolated critical value = 2.83, BP = 5.78.

Discussion

Hypothesis 1: Overall Treatment Effects

The results of the current study support Hypothesis 1. Students, regardless of group or treatment, scored significantly higher on posttest than pretest on both function construction and variable conceptualization.

This improvement is not likely due to learning during pretest. The pretest did not measure factual information which could be recalled. Rather, the translation problem is a cognitive obsticle. Subjects needed an effective treatment that addressed conceptual understanding. "Taking a pretest on algebraic equations . . . is much less likely to improve performance on a similar posttest" (Gay, 1992, p. 304).

The results of this study are consistent with the finding of Wollman's (1983) study. Using a tutorial strategy, Wollman found that 94 percent of his subjects constructed the correct equation. However, later, Wollman (1985) agreed that his subjects could have used the checking procedure to construct equations regardless of conceptual understanding. Observations conducted during the current study revealed that students did not check their answers during the tests and used either table or graphical procedures using arbitrary or given data to create their equations.

Results also indicated that students did significantly better on the variable conceptualization portion of the posttest. Students' success with variable conceptualization may have positively impacted their success with function construction. If this is the case, then Clement's (1982) report that variable understanding is one of the key issues in successful problem solution is supported by the current study.

The results might have been influenced by the combination of other instructional strategies represented by the current study's instructional treatments. These instructional strategies include learning from (1) mathematical thinking, (2) schema training , (3) linked representational systems, and (4) the coordinate graph.

The effects of mathematical thinking required by the current study's programs might have caused the improved results of the present study. Shoenfeld's (1992) mathematical thinking is embedded in engagement in scientific research, the science of patterns, and the determination of regularities in systems. The methodological framework of the *InductiveThinker* treatments included these attributes. The treatments of the current study include the inductive methodology of constructivist epistemology for reasoning and discovering via the construction of tables of variable values.

There might be an interaction effect between the improved results of the current study and the schema-training nature of the treatments. The current study's treatments include schema acquisition that eventually provides rule automation and strengthens metacognitional skills. By using tables of values and describing steps of procedures, for example, treatments increase memory demand that could hinder student's rearrangement of information and ability to construct equations.

The results could also be attributed to the anchored linked-representational systems (Kaput, 1992) property of the treatments. The current study's treatments use an inductive tutorial mode to propose, measure, and evaluate working hypotheses by representing linked representations of mathematical notations, including table, verbal, and graph representations. The programs ask learners to write down their thinking and working models, then immediately compare what they have written with appropriate examples. Students receive tabular, graphical, and numerical feedback instantly during mindful engagement with the treatment programs. In addition to the linked-representational effect, other media attributes such as mind-machine collaboration could be a positive attribute.

Hypothesis 2: Inductive Table versus Inductive Table and Graph

The significant difference is not likely the result of the longer treatment. The inductive table-and-graph program, Treatment 2, included the coordinate graph strategy in addition to other strategies. By teaching the language of graph, the coordinate graph strategy used its attributes, including geometrical graphical representation to further subjects' conceptual understanding of the translational task. Students' difficulty with translational tasks results from their use of natural language syntax and their lack of conceptual understanding of variables and function construction, not from the amount of instruction received. Persistence of translational problems has been detected among freshmen engineering students (Clement, 1982) who received extended mathematics instructions. The difference is likely to be the result of the alternative and graphical core representation of the coordinate graph.

The multivariate results related to the second hypothesis of this study indicating that graph has a significant effect in function construction are consistent with the findings of Schwarz et al. (1990), Tall and Thomas (1989), and Yerushalmy (1988).

The most important outcome of the current study is the second finding, that students receiving instructions via the inductive table-and-graph program scored significantly higher on function construction of the posttest than did students receiving the table-only treatment. Treatment 2, *InductiveThinker Table and Graph*, includes all elements of the first treatment as well as graphical representation and the teaching of the language of the graph elements. The second finding is attributed to the graphic strategy of Treatment 2 and is most likely related to the teaching of the graphic language by the treatment program. Representing linked presentations, including graphics alone, is not likely to be a major factor, since much research (Goldenberg, Lewis, & O'Keefe, 1992; Kerslake, 1981; Monk, 1992) indicates that graphic mediation has its own ambiguity that adds to the learner's syntactic translation problem.

Contrary to expectation, investigation of the second hypothesis revealed that the groups were not significantly different regarding variable conceptualization. One possible explanation for this finding is the length of Treatment 2, which was about half an hour longer, and the fact that the last questions of the posttest were related to variable conceptualization. Observations during data collection revealed that most students rushed through answering the posttest questions; many came late and, after the posttest, had to leave quickly to attend classes across campus. Another explanation might be the fact that, according to a few observation notes, posttest and pretest questions were very similar and students may have thought they were practically the same questions. The result could also be attributed to the possible testing and pretest-treatment interaction effect. A careful reexamination of the measures indicated that tables that were used in pretests for explanation of the variable questions were not used in the function construction section. This may have caused students to score higher on the pretest.

Another possible explanation is that the tests might not have been extensive enough to measure variable conceptualization. Figure 2 (in Chapter 4) indicates a ceiling effect on posttest scores. Majority of subjects achieve the highest scores possible.

Implications of the Study

Results from the present study suggest that for the problem of translation, schools may find it most beneficial to use treatments similar to *InductiveThinker Table and Graph*, that employ all learning strategies, including inquiry learning from data, tutorial, schema, and core representational systems. The present study indicates that the coordinate graph strategy is an important representational system and is very effective in translational tasks only when its language is taught by software programs and that language is understood by learners. Otherwise, the implication is that the use of coordinate graphs simply adds to the learner's syntactic translational problem. Difficulties regarding graph integration, construction, and translation must be recognized and taught to learners before they use graphs.

Before students learn how to construct functions using any of the proposed instructional solutions to the problem of translation, they need to understand the concept and use of variables (Usiskin, 1988). This study did not find significant differences between groups in the area of variable conceptualization; subjects earned maximum scores regardless of the group to which they belonged. However, function construction includes variable recognition. Students must learn to conceptualize variables in order to understand functions.

Strengths and Limitations

This study considered one of the most important problems in the teaching and learning of college algebra: the translation task in word problems. This study indicated that translation from problem situation to symbolic algebra is difficult for students, and that linking reality and mathematics symbolism requires students to engage in various stages of abstraction that include interpretation, construction, and translation. This study combined instruction treatment types examined and recommended by the experts and investigated their combined effects. Based on the literature review, this study used the conceptual richness of visuals in mathematics education — specifically, the coordinate graph, a powerful representational introduction to the complex abstractions of mathematics.

The current study addresses a solution to the problem of student's translation in algebra by proposing and evaluating a solution to the problem of function construction. This study introduced a combined instructional strategy solution that includes the coordinate graph. The combined strategy was measured against another combined strategy without the coordinate graph. This measurement allowed for a more meaningful result than would the comparison of two treatments reflecting disparate strategies. The current study used a gestalt-producing (Kaput, 1989) combined approach by including the coordinate graph in the study's proposed multiple strategies. A graph allows consolidation of pairs of related numbers into points: graphing connects algebra to geometry. A strength of the study was that, in keeping with hypotheses 2, all the effects but visual effect (the coordinate graph) remained constant in order to measure the graphical effect. For both hypotheses, the study used univariate as well as multivariate analysis.

Limitations of this study that may affect validity include (1) subjects' voluntary participation (2) the content of test measures regarding the conceptualization of variable, and (3) limited qualitative observation and analysis. Although the test items regarding the conceptualization of variables were parallel to the exercise items in the programs, more challenging conceptual understanding should be require on the tests. For example, instead of providing multiple-choice questions regarding the conceptual understanding, short-answer responses should be designed. More through qualitative observation and analysis would indicate the particular strategies students used in performing translational tasks.

Recommendations for Future Research

Further research should include the following:

- Expanded Designs: Designs that include a third group that is not exposed to a treatment to reveal possible pretest interaction
- Factorial Designs: Designs which consider the joint effect (joint interactions) of the treatments
- Qualitative Designs: Designs in which students' mathematical (translational) thinking is observed, and in which subjects are interviewed regarding their experience with the treatments

Conduct experimental research that considers other independent factors beside treatments, including sex, IQ, and mathematical background. Such research should measure the possible joint interactions of these factors on the study's output. The strength of this design would be the examination of a joint effect of sex and treatment on the dependent variable(s).Regarding function conceptualization, Drefus and Eisenberg (1983) said, "The challenge is clear; the problem is well defined. We must teach so that our students will be able to grasp global notions and find inter-relationships." Still, a decade later, MacGregor and Stacey (1993) reported that "One of the greatest difficulties for beginners in algebra is linking a mathematical situations to its formal description." Students use a naturalistic representational system — the English language — to translate word problems to functions instead of using a variety of mathematics representational systems that includes the coordinate graph. As shown by the current study, using a combined treatment that includes the coordinate graph, educators can help students to overcome the difficulty or misconception of the translational tasks.

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Creating Electronic Learning Environments: Games, Flow, and the User Interface

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Defining an environment

As computer technology increases in sophistication, so does our ability to provide users with more sophisticated learning and performance environments. Advances in the conception of computer-based environments have included Gery's (1991) notion of electronic performance support systems (EPSS), and Hannafin's (1992) description of the importance of computer-based learning environments (CBLE). CBLE's are intended to be a logical progression of our knowledge of learning theory and the capabilities of today's computer systems.

Creating a learning environment is not easy. Hannafin (1992) says that the learning environment should be a comprehensive integrated system that promotes the engagement of the learner, provides for the manipulation of information contained in a variety of media centered around a specific learning theme, and be a rich, exploratory, interactive environment. Reiber (1996) adds the important element of the learning environment being self regulated by the learner. Finding media that is centered around, or supports a particular learning theme is not difficult to do. Creating rich, exploratory interactive environments, while difficult, is not impossible. The singularly difficult task is building an environment that is truly engaging.

What is engagement?

Defining engagement is difficult because of its tendency to be relative to a particular task. There are various types of engagement. In a CBLE we are referring to the notion that the program makes the learner want to be there. There may be many reason why the learner chooses to be there. The ARCS model (Keller, 1983; 1988) offers a detailed discussion of the varying elements in the learners' motivation to learn. One reason learners choose to work in a learning environment may be that they are simply interested in the content. Interest in the content, or having a well defined question, provides the learner with intrinsic motivation to be working within the environment. Learners with intrinsic motivation may also be said to be exhibiting epistemic curiosity (Gagne, 1985). Epistemic curiosity is often caused by incongruous ideas, beliefs or attitudes about a subject, which is to say, curiosity based on lack of knowledge about a particular problem. A learner who is internally motivated may find that something as generic as a multi-media encyclopedia could serve as a learning environment. The motivation comes from within the learner, and the environment itself does not necessarily need to be engaging beyond its ability to present the content in a factual manner. If, however, the learner is not intrinsically motivated, then the environment may need to offer greater motivational features to keep the learner interested. It is not unrealistic to imagine that every learner may exhibit intrinsic motivation, and require extrinsic motivational features during the life span of the learning process, or while they are working within the learning environment. Therefore, I am defining engagement here as the nexus of intrinsic knowledge and or interest and external stimuli that promote the initial interest in, and continued use of a computer-based learning environment.

Flow Theory

Complete and total involvement in a given task is defined and described by Csikszentmihalyi's Flow Theory (Csikszentmihalyi, 1990). Flow theory is described as the feeling of optimal experience. It is felt when "...instead of being buffeted by anonymous forces, we do feel in control of our own fate. ...we feel a sense of exhilaration, a deep sense of enjoyment ... (Csikszentmihalyi, 1990, page 3). In order to reach this state of optimal experience: "There must be a goal in a symbolic domain; there have to be rules, a goal, and a way of obtaining feedback. One must be able to concentrate and interact with the opportunities at a level commensurate with one's skills" (Csikszentmihalyi, 1990, page 118). Flow is often experienced during physical activities because of the ability to realize the manifestations of the requirements of a flow experience. For many people finding a moment of *flow* can be when they are doing things that they enjoy and excel at, although flow can be experienced by nearly anyone when they are competing in an environment that is appropriate to their skills. Basketball players, even poor ones like myself, report games when everything you throw up goes in. It is when it is your day, when you are so totally engrossed in your activity that you lose yourself for the duration of the activity. You are in *the zone*. Though I might experience that zone on the playground with people at my own skill level, I am not likely to experience flow in a pick up game with NBA All Stars. The reason for this is that despite the fact that my level of play might rise to the occasion, it would never rise far enough for me to feel comfortable. The zone can be explained through flow theory. While flow is often experienced during physical activities, it occurs for different people during different activities, and has been documented to occur during the learning process. Most often flow in learning occurs at times when outside forces do not dictate what is to be learned (Csikszentmihalyi, 1990). When people are intrinsically motivated, they find themselves able to "read for hours" or "pull an all nighter" to master the content. But what happens during environments where there is no intrinsic motivation? Is it possible to provide learners in a contrived environment with the necessary tools to reach a state of flow in order to optimize the learning experience?

Video Arcades and Learning

As an undergraduate in 1983 I watched my college friends get in the zone with computer games. People standing in front of a video game console would flex their hands, stretch their shoulders to loosen up to play a video game. Once in the game, they could be in a Zen-like state of complete attachment to the task at hand. Never mind that the task was silly. Never mind that they themselves would likely never pilot a space ship and face legions of attacking aliens. Never mind the fact that all of the rules were arbitrary and contrived by someone else—they played these games. They learned every subtle nuance of the games. They often knew more about the games than they ever knew about the classes they were taking. Despite the fact that there was no authentic problem for them to solve, they found themselves completely engrossed in the task.

During studies of games (Jones, 1997) I reported that certain games engrossed people so totally that they could not stop playing. Herz (1997) describes well the intense fascination people find in computer games. It is not just the ability to play, to face danger, death, and ultimate mayhem and still come out alive. It is not solely about competition. It is about the intense feelings of engagement that a "good" game can instill in the player. In previous and ongoing studies of computer games and gamers, I have heard stories of people who played *Myst* for an entire weekend, ignoring the need to sleep in order to solve the puzzles. I have spoken with people who can tell within the first few minutes of starting a game whether or not they will play a particular game well. "I don't have the feeling today," was the comment of one gamer. There exists among many people who play games an ability to become completely in touch with one's self and one's abilities. This is due in part to one's ability, and in part due to the fact that there exists within people strong, tangible feelings of attachment to the games they play. These games engender deep feelings. Good games rock; bad games suck. One of the key reasons that a game can foster this kind of devotion is that good games tend to the total package. It is not just the graphics, sounds, and other multi media assets they use. It is about how those assets help define, support, and give life to a domain that has no counterpart in the physical world. They draw you in and make you believe. *Doom* and *Doom II* were so frightening to some players that they refused to go into the labyrinth (i.e. play the game) again (Herz, 1997). That is a powerful statement. These are truly immersive environments that support the eight major components of the flow experience. This is demonstrated in Table 1.

Enjoyment and Pleasure

Within Flow Theory, Csikzentmihalyi (1990) defines the difference between enjoyment and pleasure. Enjoyment is characterized by the feeling of forward movement, or a sense of accomplishment. Pleasure can give enjoyment and can even contribute to enjoyment. However, pleasure is defined as being passive in nature, while enjoyment requires direct participation by an individual. An optimal experience is more of a manifestation of enjoyment than pleasure. Being active in the experience tends to promote enjoyment. It is analogous to the difference of watching somebody playing basketball and playing yourself. The former is nice to watch, but the latter gives you a greater feeling of accomplishment.

Table 1. Components of flow as manifested in computer games.

Element of Flow	Manifestation in a game
1. Task that we can complete	The use of levels in a game provide small sections that lead to the completion of the entire task
2. Ability to concentrate on task	Creation of convincing worlds that draw users in. The Dungeons and Labyrinths in Doom II help you suspend your belief systems for a time.
3. Task has clear goals	Survival, collection of points, gathering of objects and artifacts, solving the puzzle
4. Task provides immediate feedback	Shoot people and they die. Find a clue, and you can put it in your bag.
5. Deep but effortless involvement (losing awareness of worry and frustration of everyday)	The creation of environments that are far removed from what we know to be real helps suspend belief systems and take one away from the ordinary
6. Exercising a sense of control over their actions	Mastering the controls of the game, such as mouse movement or keyboard combinations
7. Concern for self disappears during flow, but sense of self is stronger after flow activity	Many games provide for an environment that is a simulation of life and death. One can cheat death and not really die. People stay up all night to play these games. It is the creation of an integration of presentation, problem, and control over the system that promotes this.
8. Sense of duration of time is altered.	Years can be played out in hours. Battles can be conducted in minutes. The key point is that people can stay up all night playing these games.

In computer games, certain features provide pleasure: good graphics, nice music, visual effects, and interesting animations are aesthetically pleasing, but do not necessarily contribute to creating a good game. What makes a game "good" is a good problem that is manifested appropriately. It does not matter if it is rendered elegantly, but that it is rendered in a manner consistent with the problem. Herz (1997) presents convincing arguments that graphically minimal games of the late 1970's and early 1980's (such as *Tempest* and *Pac Man*) were actually more engaging than more recent games that provide a much greater level of graphic detail. Much of this has to do with the problem facing the user and how it is manifested. Problems that have meaning, that stretch one's abilities to the limits are more likely to provide feelings of flow than easy problems: we like to be challenged. If we are to relate this notion to the development of learning environments, it might suggest that we need to help the learner define a problem within the environment, or that perhaps the environment itself could represent a manifestation of a problem. This might be accomplished by building tools into the learning environment that help learners solve a problem. Even drill and practice activities can help maintain a level of involvement on the part of the learners.

Cognition and Flow

It might be argued that one could make a relationship between cognition and flow as it relates to CBLE's. Norman (1993) speaks of two kinds of cognition: experiential and reflective. Experiential cognition is one where one may react to events efficiently and effortlessly. An example of this would be the way people who play action games such as *Doom II* exhibit this type of cognition. It is a combination of skill, reflexes, and knowledge that comes together after many hours of practice. Reflective cognition is that of comparison and contrast of thought, of decision making. It is the type of cognition that leads to new ideas and novel responses. Strategy games, such as *Warcraft II*, or puzzle games such as *Myst*, require the use of this type of cognition. In working with complex tasks, it is usually necessary to combine both reflective and experiential cognition to solve problems. It is likely that in order to reach flow that one must use both types of cognition. One would need efficient, seemingly effortless skills

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related to one's ability level (experiential cognition) and the ability to assimilate and accommodate new information (reflective cognition) in order to do most activities well enough to reach a state of flow.

Relating these ideas to the design of a CBLE may mean that lack of attention to aesthetics may make a program less likely to be used, but mere inclusion of aesthetically pleasing elements does not guarantee that the elements will promote learning, or add to the enjoyment of the program. Pleasure can be had or developed through seductive bells and whistles that are added on to a program. Enjoyment might occur because the bells and whistles were used as intentional pieces of the environment. The bells and whistles, or multi-media assets, employed in an environment should be used to promote the workings of the environment. Music that is used in games can help underscore emotions. The fast, hard pounding music in *Doom II* causes one's adrenaline to increase in an action game, where as the ephemeral background music in *Myst* helps enrich the feeling of mystery. Beyond the ability of the multi-media assets to support enjoyment by helping to support or carry forth a consistent tone, enjoyment can only be had when there is some conflict between what you know, and what you want to know, which is the essential component of cognitive conflict (Piaget, 1980; Gagne, 1985). Cognitive conflict stretches our desire to know and do more. It is a confrontation between the learners' current knowledge and the learners' expectations or ambitions. It is the challenge needed to begin flow experience. A possible way to build this conflict into a CBLE is through the use of environmental juxtaposition.

Building an environment

When thinking of a learning environment, I prefer to work with Reiber's notion of an endogenous learning environment (Reiber, 1996). In these environments, the content and its structure are so closely related that "one cannot tell where the content stops and the game begins" (Reiber, 1996, page 50). One place where this notion of endogenous environments is most notable is in the area of commercial computer games. The games themselves are motivating, and weave a fabric of content and fantasy so seamlessly that one can become lost in the game for hours.

Environmental Juxtaposition

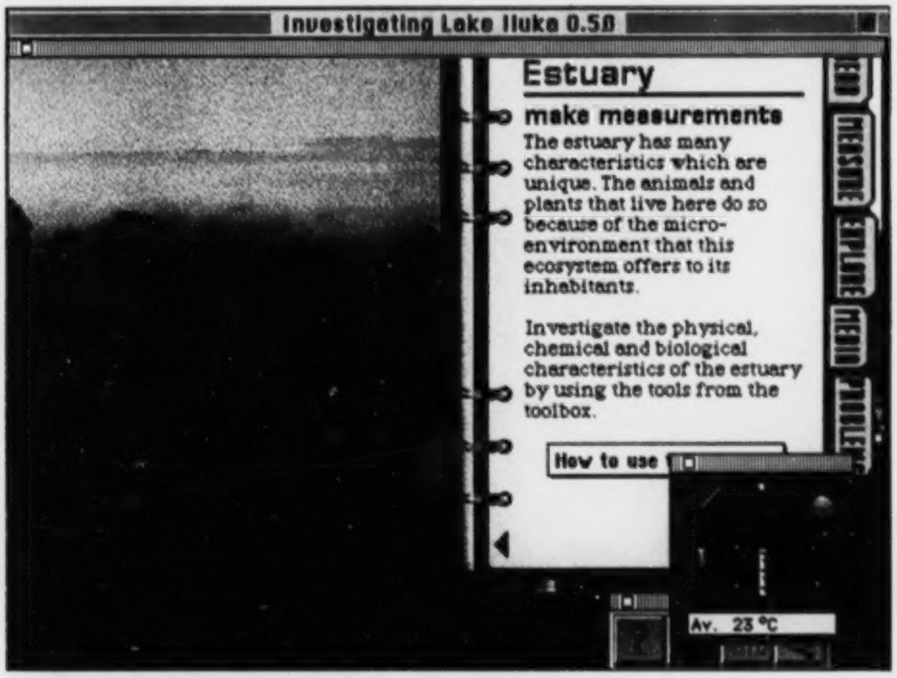
Much of the content of a computer-based learning environment is presented visually, and surrounded by or supported by some type of theme. Visually, an endogenous environment strives for seamless integration of the program's theme, content, and the patterns of interaction used in the game or other type of environment. The original pattern of interaction in a computer game was that of slide and shoot. Your agent in the game resided on a horizontal plain, and moved left to right while attacking agents moved on a vertical plain. This was begun in *Space Invaders*, and can still be seen, though more elegantly rendered, in current games such as *Mortal Kombat*. This interaction pattern has grown into a roam and shoot pattern of interaction. No longer must you wait for the enemy to come to you: now you can go out and hunt them down. *Myst* defined a new pattern of interaction. You search for clues within an environment. These clues help not only to solve the puzzle, but to figure out how the world works as well. Typically, when moving within a game, the game's controls work in concert with the game's content to provide a seamless integration of content and control. This is a good thing. However, it is sometimes desirable to impose some type of juxtaposition on the environment, and ultimately the learner.

Occasional juxtaposition or conflict within the user interface can keep people moving and engaged. The Monty Python games are excellent examples of this. In *Monty Python's Quest for the Holy Grail*, unexpected surprises keep the users engaged. However, one might argue that Monty Python products would not be complete without significant juxtaposition between the environment you are in and the surprises they throw at you.

Juxtaposition integrated between content and control might suggest that stimulus and response is not all that bad of an idea in a computer-based learning environment. Early computer-based instructional programs were often criticized as being electronic page turners. They did not engage the learner at a level beyond passive viewing. Learners need to be engaged in the educational process, and actively engaged in the content and the business of learning. Learners should be doing things in the software. Clicking on timelines, accessing pop-up text or graphics, clicking and dragging objects are all examples of active techniques used in CBLE's. Additionally building tools within the learning environment extend the notion of educational software to the arena of application software. Instead of being simply a reference tool, the software becomes a tool for calculating, comparing, and generally working on a problem. *Investigating Lake Iluca* , a multi-media learning environment created at the University of Wollongong, Wollongong , Australia, was one of the first pieces of software I saw that did this (See Figure 1).

Tools were there for testing soil and water, notebooks were there for learners to write down notes and store information to study later. These tools take away from the visual consistency of the program. In a two dimensional environment that is displayed on a computer screen, it is necessary to treat different locations through the functionality of multiple windows. The tools work on the lake, but the tool pallete can cover other areas of the screen. However, the juxtaposition they provide is pedagogically significant, relatively seamless, and ultimately helpful and not distracting (See Figure 1).

In contrast, a *Doom* like simulation of a banking computer-based training program is juxtaposition that fails. Filipczak (1997) describes a Doom like environment where the main character must catch "clients" running around on the screen and shoot monsters (which represent clients' problems) (see figure 2).



Estuary

make measurements

The estuary has many characteristics which are unique. The animals and plants that live here do so because of the micro-environment that this ecosystem offers to its inhabitants.

Investigate the physical, chemical and biological characteristics of the estuary by using the tools from the toolbox.

Figure 1. Tools from Investigating Lake Iluca.

When you catch a client, you are then taken to a multiple choice question screen where you must answer a policy question. If you get the question correct, you can continue playing. If you don't, then you must return to a "traditional CBT tutorial" to study the fact. I must confess that I have not seen this, and have only read its description. But if I understand this correctly, then the game is not part of the training, and the training is not part of the game. The game, as stated in this online article "…rides along with the course serving two functions: It relieves boredom by letting students take a break from the self-paced instruction; and it serves as a motivator/refresher, giving students an immediate reason to study and recall the information, and a reward when they do." From this description, it sounds like a classic example of something not to do. It is "gamus interuptus." An environment such as this could never engender flow because the environment would be constantly interrupted by switching between instruction, game, and test. It is not that it is impossible to do, but it may be that Doom is simply an inappropriate model to follow for the training. An integrated environment could engender flow. In order to have an integrated environment, one must consider carefully an integration of the content, the controls, and the patterns of interaction. In the Doom like simulation described, there are in fact three patterns of interaction. One is the traditional CBT, the second is the game, and the third is the multiple choice questions. While some juxtaposition might keep users on task and alert, this is simply far too much juxtaposition of content and patterns of interaction.

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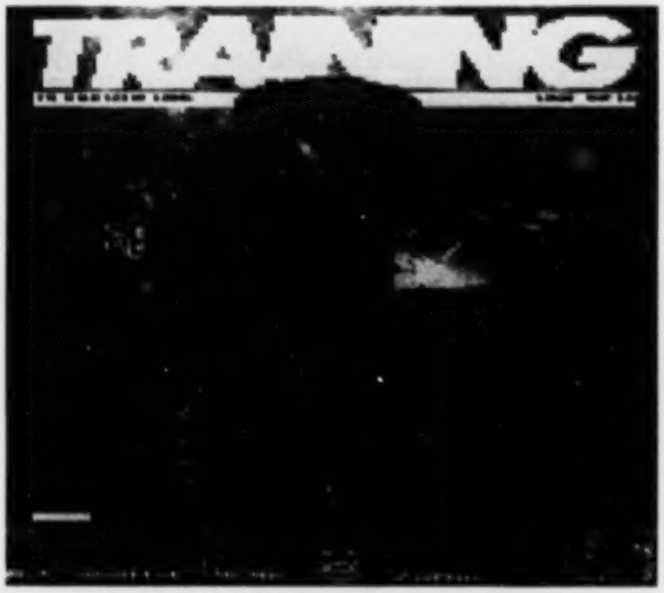

Figure 2. Rendering of the Doom-like game from Training Magazine.

Building an Environment that uses games to engender Flow

Attention to detail

One thing seems to be abundantly clear in planning and building these types of environments: neatness counts. The quality of the multi-media assets such as images, sounds, and animations, are a key factor in getting people interested in the game, and interested in playing the game. This is an important issue to be considered in the design and development of educational software. Rather than "settling" for assets, we should be working to find appropriate, quality images and sounds to make learning environments richer, and ultimately more meaningful and enjoyable experiences. However, it is important to note that while attention to detail is important, they should have a purpose to them. As one participant in a previous study stated, "I don't know why they put those (video clips) in there. Probably because they could." Some features were included in games that while technically impressive, had no real relationship to the environment created. This is true in many pieces of educational software as well. Pushing the envelope is a noble ambition (Jones, Farquhar, & Surry, 1995), but pushing the envelope should be done relative to the environment itself, and not simply because it is possible. Figure 3 shows an example of a Main Menu within a learning environment on the saxophone. The environment itself is striving for a "cool" tone. In order to draw the users into the program, it plays upon the learners knowledge of the saxophone as a jazz instrument. The program seeks to establish a tone similar to that of a Jazz Club. The main menu then becomes a "set list," and many of the other controls and features of the program take on the tone of "cool jazz." From background graphics and music to buttons, having this supportive theme helps carry forward the theme. Additionally, it creates an environment where control and content work together.

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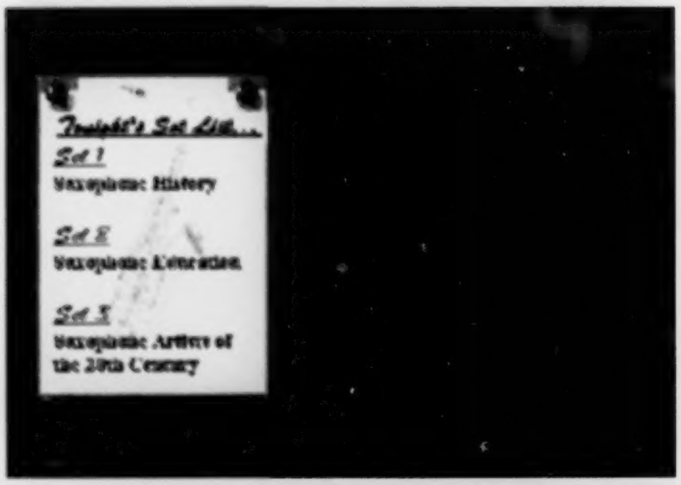

Figure 3. Use of multiple assets to create an environment. Jazz music runs in the background.

Applying Experiential and Reflective Cognition

Strategy games are ones in which the user must employ higher order thinking skills and problem solving skills to continue playing and win the game. This supports the notion of reflective cognition set forth by Norman (1993). Twitch games, also called *Thumb Candy* (Herz, 1997), are games in which the user must react quickly to circumstances, usually by killing someone, to continue playing and win the game. *SimCity* and *War Craft II* are immediate examples of strategy games, while games like *Doom* are consummate twitch games. The advantage to a twitch game is that the movement is quick, and the feedback immediate. This works to keep the user actively engaged. However the level of this engagement is often superficial. It does not typically engage one beyond the most basic level of seeing, pointing, and clicking. Strategy games require the user to look at the larger problem, and plan a strategy to solve the problem. In some games, such as *SimCity*, the results of your decisions are not immediately recognized. You must have a fair amount of internal motivation to stay with the game to realize the fruits of your labor. While twitch games offer immediate results of your work, strategy games appear to offer a greater feeling of accomplishment and satisfaction. One participant who was playing *War Craft* praised the combination of "twitch and strategy." While they ultimately liked working on complex problems in an environment, they also appreciated the sheer visceral rush of immediate feedback. One manifestation of this in a CBLE might be seen in Figure 4. In a program dealing with primary colors for pre-readers, users interact with the content by clicking and dragging, one of the most common methods of interaction on the computer. They are given paint brushes to drag on to a picture. If the correct brushes are used to create the correct color combination, then the paintbrushes change color, and the learner "paints" the picture the correct color. The controls in this exercise are indistinguishable from the content of the program, and the method of interaction, though common, serves to engage the learner both physically and intellectually.

From Games to Flow

Returning to the table that relates elements of flow to manifestations in a computer game, what follows is an effort to show possible manifestations of flow activities in a CBLE.

Conclusions

Simply put, when an individual is in a state of flow, they lose themselves. When an individual is engaged in a CBLE, they are engaged in the process of learning. It is conceivable that attending to the visual and aesthetic sensibilities of an environment can make it more engaging. It has been suggested here that certain aspects of the flow experience can be manifested in CBLE. By looking to computer games, which are engaging computer-based environments, one can possibly ferret out principles for engagement. Suggestions for incorporating gaming practices have been set forth by Jones (1997). The idea of combining flow theory with the design of computer-based learning environments is an area that is should be considered for further study.

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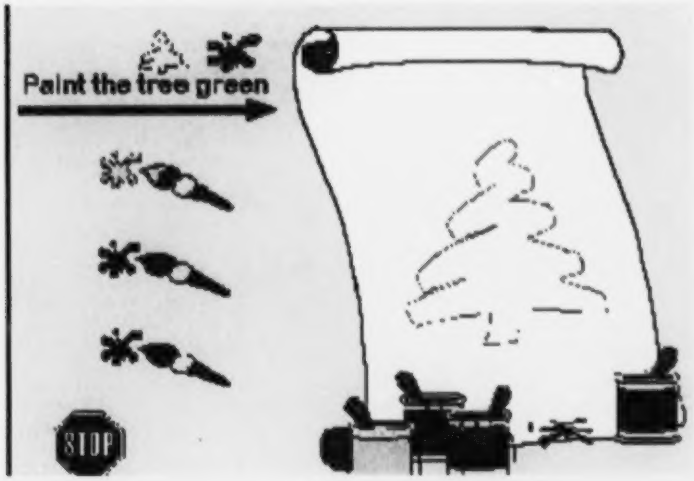
Paint the tree green
STOP

Figure 4. Use of tools to engage the learner in a CBLE.

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Table 2. Relationship between Flow, games, and design of CBLE's.

Element of Flow	Manifestation in a game	Possible manifestation in a CBLE
1. Task that we can complete	The use of levels in a game provide small sections that lead to the completion of the entire task	Exercises relevant to the content area that provide "drill and practice" types of activities might provide learners with areas of skill to focus on. Also aids in reinforcement.
2. Ability to concentrate on task	Creation of convincing worlds that draw users in. The Dungeons and Labyrinths in Doom II help you suspend your belief systems for a time.	Creation of seamless integration of tools, tasks, and presentation of information.
3. Task has clear goals	Survival, collection of points, gathering of objects and artifacts, solving the puzzle	Provide problems within a learning environment. Despite the desire to have learners determine their own problems, it can help to have initial problems identified for them.
4. Task provides immediate feedback	Shoot people and they die. Find a clue, and you can put it in your bag.	Combining appropriate tools with the software can provide users with mechanisms for meeting goals and gaining feedback from the software (See Figure 1).
5. Deep but effortless involvement (losing awareness of worry and frustration of everyday)	The creation of environments that are far removed from what we know to be real helps suspend belief systems and take one away from the ordinary	Keeping the visual appearance of the environment can maintain consistency which may help keep users focused on the task at hand. Less environmental juxtaposition may help keep users focused (See Figure 3).
6. Exercising a sense of control over their actions	Mastering the controls of the game, such as mouse movement of keyboard combinations	Providing for more direct control by the learner. More learner directed movement than designer determined paths.
7. Concern for self disappears during flow, but sense of self is stronger after flow activity	Many games provide for an environment that is a simulation of life and death. One can cheat death and not really die. People stay up all night to play these games. It is the creation of an integration of presentation, problem, and control over the system that promotes this.	Tools that promote self confidence (achievable goals, tasks that are level appropriate) can help strengthen sense of self and help generate greater self efficacy (See Figure 4).
8. Sense of duration of time is altered.	Years can be played out in hours. Battles can be conducted in minutes.	Chunking of information can help keep people moving. Closure (Jones Okey, 1995) can keep users working.

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What We Know about Research in Instructional Technology: Interviews with Research Leaders

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Penn State University

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NovaNET Learning

Introduction

This is not a typical research paper. This is a paper about research. In 1994, four fairly recent doctoral graduates of the university of Georgia were discussing the possibilities of publishing on the World Wide Web. We established Instructional Research Online (InTRO) as a repository of research papers, media, and other artifacts related to research in Instructional Technology. Defining a direction for InTRO was, and remains an iterative process. The website (available: http://intro.base.org) includes sections on reviews of books and media, original research, links to resources in instructional technology, and interviews with research leaders. One feature that has helped define InTRO and its purpose has been the section on interviews with research leaders.

These interviews are informal conversations with people who conduct research in the field of instructional technology. The purpose of the interviews is to gain insight into the processes and issues of research in the field of instructional technology by conversing with people who have significant experience engaging in research in and tangential to our field.

Our practice of interviewing research leaders may have grown out of a doctoral seminar in research at the University of Georgia taught by Tom Reeves. The culminating assignment of the course was to focus on a research leader in instructional technology and to read from that person's body of research. Analyzing this body of work, you could begin to see what somebody's research agenda was, how their research had remained focused on a single area, shifted slightly, or shifted radically. The final phase of this assignment was to contact this person and interview them. All of the information was assimilated and presented back to the class.

The practice of interviewing research leaders was a valuable one. We may have learned as much from talking to these people personally as we did by reading journal articles authored by them. We certainly came to realize that people who are regarded as leaders in research in our field can also be pleasant people who are interested and willing to talk about their work. Much of what was learned about research in this class was through contact with people on a personal level. One reason for this may be that much of what people know is not set forth in print. It is informal knowledge, or patterns of understanding that may not be documented, codified, or shared formally.

Most of us will recognize that there are times when we learn as much working on projects as we learn sitting in classes. For example, while one may study front end analysis it is not until one does an actual analysis that one realizes the practical application of gathering information about an instructional environment. Work in practical settings helps inform, reinforce, and extend what we study. One reason for this is that when we work on projects we work with people who know more than we do, and we are able to tap into the informal body of knowledge that they hold. This is true in the study of research as well. Informal conversations about research are important in helping form opinions on research, and in helping people figure out how to conduct research.

In our interviews we were interested not only in what kind of research these people were doing, but we were also interested in what advice they might have to people in the field interested in conducting research. It remains our contention that there is much to be learned from people who conduct research. Fittingly enough, our first research leader interview was with Tom Reeves.

Selection of Leaders

In every field there are individuals who are regarded as leaders or, if you will, bellwethers for the field. Their work is generally recognized as important because it not only informs the field, but it also *shapes* the direction of the field. Their work may not always be agreed with, but it is recognized as important and significant. It helps to challenge what we know in order that we may ultimately know more.

The selection of leaders for our interviews is an ongoing process; we continue to conduct and publish interviews. Our original selection of leaders to interview was certainly based on their contributions to the field, but other factors may have played a role in their selection as well. The InTRO editorial board started as a team of young researchers. While we did the initial screening without any formal selection criteria, we did work to select a balance of perspectives. It was and remains a goal to include people from different institutions and different research areas. We have included not only people conducting research in academe, but also people conducting research in industry.

We tended to interview people who had a significant number of publications, and who had been in the field for more than 10 years. We looked to people who were active in professional organizations such as AECT, and we have striven to include a diversity of views from a diverse group of people. Given that we all have some connection to UGA (Susan Land, our most recent editor graduated from Florida State University but did a postdoc at UGA) our sample may be biased towards that institution. Additionally, there is a fair amount of self selection among our interviewees as a number of our requests for interviews have been declined. Consequently the people represented in these interviews do represent good, interesting, and challenging perspectives, though they may not represent every perspective at this point. It should be stated that the InTRO editorial board is always open to suggestions on research leaders to interview.

Analyzing the Interviews

The purpose of this paper is to identify and report on an analysis of the published interviews. Interviews are conducted via email. Typically, we review a researcher's work, and then email them a set of questions based on that review that we think will be of interest to our audience. Once we receive the researcher's response we then send a set of follow-up questions. We compile these with the original responses, ask the interviewee to review it, and then post it on InTRO.

The following analysis represents a unique opportunity for the reader. All of the data we have available to us is available to you. This analysis represents what was said during the course of the interviews, and unlike other types of interviews used in research, we were not able to go back and ask for clarification after analysis had begun. This is not, in the strictest sense, a research article. It is a synthesis of comments, suggestions, and other important points made by the interviewees. We make this distinction because we feel that there are conclusions that we think are appropriate, but are simply not borne out in the interviews. There are conclusions that could be drawn in this paper based on personal experience *and* the interviews, but we shall refrain from making those in this paper. We wish to concentrate on setting forth only what can be drawn from the interviews themselves. There are obviously many interpretations that are possible based on the interviews. This paper and the accompanying presentation represents one. We invite you to draw others for yourselves. And with that invitation we also extend to you the invitation to formalize your interpretations and submit them to InTRO for publication.

How to identify a problem: A question of questions

The journey of a thousand miles is begun with a single step. This may be true, but if you are unclear on the direction in which your first step should be, your journey may not go that well. This is the problem many people have in conducting research: it is hard to identify a unique question. The interviews provide some help in this area.

Gaining confidence

Nearly everyone working on research issues has faced the problem of identifying an area in which to do research. There is no shortage of important questions to ask, or important issues to study according to the interviewees, but they do recognize that people find it hard to get started in research. Most people who find it hard to identify a problem may not suffer from a lack of ideas, but rather from a lack of confidence that their ideas were good and viable. It is suggested by our researchers that one thing that has made them "good" at research has been believing that their ideas were important and of interest. They have learned to analyze questions, and to "trust their instincts" when looking at problems in the field. One thing that has helped them "trust their instincts" has been the involvement of a good mentor or good colleagues who can serve as a sounding board for idea. Mentors and colleagues can help people gain support for their ideas and give them the encouragement they need to pursue them.

Reviewing the literature

There are many ways that a researcher can gain support for their ideas. One is by careful consideration of the existing research. One sound and practical method suggested on how to identify a research area is to think about the areas that you want to know something about and go read about them. As you read you may find "holes" in the literature, that is to say areas in the literature where significant questions are going unanswered. If you want an answer to a question, but there exists no answer in the literature, then that is an area of research to pursue. The "holes" are where you should be working. Reading and understanding the literature is critically important, as is the ability to read and synthesize large bodies of research. One researcher feels that the work they have done in writing literature reviews is the most difficult, but possibly the most important work that they have done.

Finding studies and other articles that support your research ideas is only one reason to consider the literature carefully. Finding absolutely no consideration of your ideas in the literature is a fairly compelling indication that a pressing need for your work exists. Again, this is looking at the holes in the literature and focusing your work to fill those holes. As you begin to do research, your work begins to help answer important questions, but may not be able to answer every question. We are reminded by many research leaders that few individuals will make a difference with one piece of work. Collectively we contribute to the body of literature in the field. The knowledge base grows as more people ask and answer questions. The combined total of all of this asking and answering is what we know in the field of instructional technology. It is contributing to this body of knowledge that is important.

Finding questions in real world environments

Still, many people are simply trying to get an idea started. Reading the literature and finding holes in the problem may seem overwhelming to some. Beyond being overwhelming, it may not be practical to gain all questions from the literature. Looking at naturally occurring environments is one way to find out what questions are out there. One piece of advice is for researchers to go into educational environments, such as schools, and observe people using an educational product. We should look to see where they are having problems, what is making sense to the user, and what is confounding the user. Noting these problems can provide excellent sources for ideas in research.

Combining observations and literature can help inform your reading, and help to isolate problems that literature can then be associated with. It is not only the observations of people using other people's products that can lead to interesting research projects, but it is also observing people working with products that we develop that can inform research questions.

Instructional technologists are involved in a number of efforts. In addition to reading, we may be working on media design and development projects. Practical experience, especially for people new to the field, provide us with activities that enable us to gain a better insight in to the way the field works, and what it means to work in the field. Many of the researchers interviewed here point to the close bond between research and development. Problems encountered during a development project often lead to interesting research questions. Leaders who have worked in industry state that their experience in project work has been the driving force in many of their research activities. This points towards the important relationship between research and development.

The relationship between research and development

Instructional Technology is an active field, and it is important to remember that in the final analysis it is our job to make a positive impact in the way that people learn. Saettler (1990) reminds us that technology in our field is defined quite broadly. We work with hard technologies, sometimes referred to as "things that plug in," but we also work with soft technologies, or "advances in thought." Always, we are looking forward. Though much of what we do is practical in nature, even studies in seemingly esoteric areas such as post modernism are used to inform our work. In our field, research certainly influences practice. However, this is a reciprocal arrangement because often times in instructional technology practice influences research.

Blurring lines

Most research leaders find that the boundaries between work interests and research interests blur significantly. Many researchers with advanced degrees have worked for years before returning to study for an advanced degree and pursuing a career that involves research. Because of this, many of their initial research questions cam from their work experiences. As they continued to do research, they also continued to do work in the field. Some of that work may have been in the design and/or the development of educational programs. For many of our interviewees, they were involved in significant evaluation activities. While the type of work may vary, what remains constant is the connection between work experiences and research projects. Many researchers may serve dual roles. They may design the environment conduct research on both the process of building the environment and the ultimate value of the finished environment. This indicates a very strong connection between research and development, and suggests that it is not only common for researchers in instructional technology to also be designers and developers of instructional products, but that it is also highly desirable.

One researcher recommended that working on projects was so important that young academics should do it for free if need be. The practical applications of this work can greatly improve your skills as a researcher and keep you in touch with what the field is doing. So while most leaders in research tend to credit the real life experience they have, they recognize it as not only important in giving them experience, but in keeping them current as well.

Connecting research and practice

Combing research and development may be desirable, but what can be difficult is making the results of your research valuable to others. We face a problem with research in our field according to our researchers. Chiefly we don't connect practitioners to research as seamlessly as we might desire. It is often assumed that the role of a researcher is to tell the practitioner what to do. However, people who are working in the field everyday have many ideas that can make interesting research questions, or may have answers to many significant questions in our field. In instructional technology, many active researchers are also practicing professionals, but the connection between practice and research should be made stronger. It has been suggested by some leaders that our research efforts should be focused on making information available to practitioners in schools, industrial, or military applications. Our research, and the results of our research, need to be more accessible to practitioners. Our research, and our field, needs to make a greater impact on the environments in which we work; our research results need to be more practical.

The most important piece of work

Finding interesting work and letting it guide your research can make your research not only more valuable to the field, but more interesting to yourself as well. Many of our interviewees are remembered for a "seminal work" or a particular theory or line of inquiry that they have been working on for a period of time. However nearly all of them expressed that the most interesting thing that they had done was what they were working on now. This indicates a passion for research, and a commitment to new ideas. It would be hard to be involved in a project if you were not interested in it. Therefore one recommendation made is that you work to find projects that can hold your interest.

Doing research on your work is a piece of advice that is often heeded by many people. Working in the field is both professionally and personally rewarding. Because many of the researchers point out that we need to be studying naturally occurring environments to see how people learn, working in environments becomes even more critical. Finding a naturally occurring environment in which you can work is not easy. Establishing yourself by working on a project, or in an educational environment can make research populations available to you.

Choosing a mentor

There is much to know about research. There is the problem of identifying questions, seeking funding, managing the process, and ultimately disseminating your work and writing for publication. One of the most important things a novice researcher can do is to seek out a mentor to help them learn and master this process. The definition of mentor here is not limited to the relationship between a student and a professor in graduate school. A novice researcher is well advised to seek out others in the field who can help them work in the area of research. Many leaders advise not only the novice to search out mentors, but also the mentors to treat their apprentices in a collegial manner.

The role of the mentor

Mentors can do a lot for an apprentice. Beyond simply teaching them how to do things, they can introduce them to people in the field, or involve them in research and writing projects. Apprentices gain valuable experience in writing for publication from their mentors. But ultimately what the mentor can offer to an apprentice is confidence, and confidence is one of the most important skills one can develop as a researcher. To submit your work to the rigors of the referee process, one needs to have a bit of an ego, and a thick skin. Mentors can help novice researchers develop these in the right amount and appropriate manner. One researcher relates a story of how they were "cooked" good by a discussant at a conference. The presentation went abysmally, but ultimately the paper was reworked and published. The research, ideas, and the paper had value, but that value wasn't recognized during the first presentation of the idea. It was not until sometime later that the paper made it into publication. The point is that simply because one person does not like or agree with a research idea it does not mean that the idea should not be pursued. Mentors can help apprentices see this and gain the skills and confidence they need to continue working when an idea is rejected.

The role of the apprentice

An apprentice can offer much to the mentor as well. Often times, it is an apprentice that gets their mentor involved in a particular project or line of research. One suggested reason for this is that mentors work with more and more apprentices. While a mentor may have spent their time reading and writing in the past, more and more of their time is spent working with more and more people. It becomes a challenge to stay abreast of everything that is going on in the field. Often times it is the apprentice, who can focus their efforts and energies more narrowly, who can point the mentor in a new direction. The point here is one of collegiality. It is generally recognized that people working together can bring diverse views, skills, and ideas to a project. The same is true of the relationship between the mentor and the apprentice. Care should be taken in choosing a mentor. You should choose a mentor who not only publishes, but who publishes with their apprentices. Novice researchers, or people in their first academic position, should choose a mentor where they work who can help them find resources, locate outlets for publishing, and help them learn to write grants.

Most people recognize that the mentor has much to offer the apprentice. It is suggested here that the apprentice also has much to offer the mentor. This reciprocal relationship promotes not only a greater understanding of the field to the novice researcher, but also helps keep the mentor current in working with others in the field.

One caveat- one of our interviewees points out that there simply may not be enough mentors to go around. Mentoring takes a lot of time and entails a special relationship between the faculty and students. Given the fairly large student faculty ratio in many of our programs it may not be possible for every student to have a mentor. In fact, it may be the case that if your are fortunate enough to have a mentor, then you are fortunate indeed.

A question of methods

The issue of whether to do qualitative or quantitative research is one that most researchers are faced with. Historically, much of the research that was done in education in general and instructional technology specifically, was quantitative in its planning and execution. For many years, faculty supervising research were trained solely in statistical research methods. Today, more and more researchers are looking to alternative research methodologies such as qualitative research.

Research traditions

Much of our research methodology has been derived from the hard sciences. There are many reasons for this. Historically the field of education has constructed controlled environments in which to test single or multiple variables. Most often these were contrived environments, and if you look at research in the field of instructional technology you will see that most of the research in the past several years still follows this paradigm (Reeves, 1995).

Many researchers interviewed here state that their initial research involved isolating single variables and working with them in a controlled environment. One reason for this may be that many of our research leaders originally were psychologists, or educational psychologists trained in the dominant research paradigm of the times.

The dominant research paradigm for many years has been quasi-experimental studies. People researched in a manner in which they were taught to research. Some leaders suggest that much of their initial research agenda, while interesting to them, was also driven by the tenure and promotion process. A combination of history and environment has driven the field for years in the types of methods and research tools it uses. Currently, most leaders are recognizing that there are more tools available to researchers today and are seeking to use these tools in research.

Mixed methods

A recurring message from nearly all our research leaders is to avoid the qualitative versus quantitative debate entirely. This debate has been characterized as "mindless" by some people. Our research history, and much of our current research recognizes the need to isolate variables. However much of our current research also realizes that variables in the real world are not really controllable, and they rarely behave like the variables that are able to be controlled in the world of physical science. Most of the people interviewed here work with the philosophy that in order to answer certain questions you will need certain sets of tools, and therefore suggest that researchers study and develop skills in both qualitative and quantitative research methods. When an environment presents itself you will then be ready to study it regardless of what questions may need to be asked, or what tools are needed to answer the questions.

Additionally, some of the leaders interviewed here suggest that beyond qualitative and quantitative research methods, there exists the need to consider issues in yet more divergent research paradigms. Among these are the methods associated with post modernism, semiotics, and historical research. Additionally there are at least two researchers who make the argument that our research not only needs to be more responsive to practitioners, but that it needs to be more responsive to society as well. There is small, but growing call in the field for socially responsible research in instructional technology.

Disseminating research

Research is done to inform practice, and the results of research are meant to be shared with the larger community. Disseminating research begins with having questions that need answering, and culminates in the publication of that research.

The research agenda

Traditionally research is disseminated in two formal ways: the conference presentation and the journal article. Informally the results of research can be spread through informal conversation among colleagues. People need to share the results of their research so that they can not only make sense out of what they are doing, but also so that may gain insight into the next phase of the research, or the next study in a long term research agenda. Many people speak of research as a pipeline. You conduct work on an idea that gets proposed to a conference. The initial paper is done and presented at a conference. Based on reactions and feedback at the conference the paper is reworked for submission to a refereed journal. While you are working on one project, you should be considering other issues that you can work on later. Work that can be proposed to conferences the next year will keep you busy after one piece goes in to print. The goal is to keep the pipeline full at all times, meaning that there should always be a project to work on. For those in a tenure earning position, it should be noted that the tenure process is too short to begin work in distinctly different areas, but that rather you should focus your work within a common framework. This common framework, or area of research is often referred to as a research agenda.

For most researchers, the research agenda will start with the dissertation or thesis and move forward from there. While many researchers can and do make dramatic shifts in their research interests, most tend to work in a broad area such as evaluation, computer-based learning environments, electronic performance support systems, cross cultural research, or the processes associated with instructional design to name but a few. The key point is that by staking out an area in which to work a researcher does a couple of significant things. They focus on key problems and become recognized as a person who can inform this small area of the field. Taken in concert with other people working in either similar areas, or in completely different areas, a fabric is woven that constitutes the body of research in the field. By establishing a research agenda, or a line of inquiry, a researcher gets to the business of making a contribution by advancing the knowledge of the field. As you become recognized as an expert in that area, you can begin to help others conduct research in that area, and you can begin to make connections between your research area and other research areas. For example a person with significant research experience in distance education could team up with a person with significant experience in hypertext to conduct research in web-based instruction. The two areas inform each other, and can be used to move forward into a new area. The two areas do not represent mere appurtenances to each other, but rather represent unique applications of divergent areas.

Writing research

People in the "real world" are interested in our work, but they find it hard to put their hands on the information they need easily. This is suggested by more than one researcher. Our field is filled with three letter acronyms (TLA's) that are often seen as cliquish in nature and make it sometimes more difficult for people to use the results of our research than we would intend. While it raises the question of "who do you write for, it may also suggest that rather than saying things to sound intellectual, we should simply say what we mean. We should avoid confusing language, or, as the bumper sticker says: "Eschew obfuscation."

It is a recurring theme in nearly all of the interviews that one of the biggest problems we face as a field is in having our work make a difference in the life of the individual, and that one of the ways in which we can achieve this is through the dissemination of our research. Clarity of writing is stressed, as is the age-old soul of wit, brevity.

Conferences and journals

Conference presentations and journal articles remain the two most common ways to disseminate research. While not mentioned in the interviews directly, it is well known that the lag time between writing and publication can be fatal to a new idea: by the time the new idea gets published the idea is already generally recognized as being obsolete. Most of us will have to begin planning what our conference presentations will be so long before the conference even begins that some ideas may be found to be inappropriate by the time the conference arrives.

One reason that it can take so long for research results to be published is the referee process. It does take time for busy people to read their colleagues' work carefully and make decisions on its appropriateness for publication. Web-based publishing has been mentioned by more than one researcher as an alternative to the traditional paper based journals. While changing the medium itself is not likely to yield dramatic results, it is possible that it could speed up both the publication speed and help increase access to the published research.

Conclusions

Hannafin and Hannafin (1995) warn that in the future IT might "continue its emphasis on training practitioners, but will be unable to forge its own destiny and advance its own research." (P. 320) It is important that we pay greater attention to research and to training researchers if we are to avoid this somewhat dire consequence. Becoming a researcher is not the same thing as learning to do research. We can learn research methodology in our classes on quantitative and qualitative analysis. We can learn to do literature reviews through research seminars. But knowing these things does not guarantee that one will be able to put them together in an intelligent, scholarly, and creative fashion. Only by working with those among us who are already doing quality research, can we began to discover how to synthesize these elements in such a fashion as to do quality research ourselves. There may not be enough mentors to go around. But we hope that through the interviews with the research leaders on InTRO we can assist those mentors among us in reaching and in teaching enough of us to make a difference.

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14th Foundations Symposium
Continuing The Debates/Discussions Of The Foundations Of Our Field.

Education And Community*

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The National Film Board of Canada produced a film a few years ago called "The Manufacturing of Consent." This film was about Noam Chomsky's text of the same title and had to do with the mass media and the presentation of public information. The film is a very nice critique of our conference. We three presenters have one hour and fifteen minutes to present, essentially, three different views regarding the foundations of the nature of our field, as well as allow for your participation. The key word is "concision". The reality is, concision is impossible when presenting complex ideas and positions on the nature of our field. But.... here is one of the presentations.

Foundations symposia in the past have always tried to deal with the larger questions concerning educational technology, schooling, and society. These symposia have taken the form of discussions centered on the philosophical, historical, psychological, and sociological foundations of our work. It has been the belief of those of us who have participated in these symposia that foundations disciplines raise substantive questions regarding the nature of our work. This notion of foundations is not meant to suggest meta-narratives of the "right" interpretations, representations, or approaches to our work, but more of the diversity of our approaches toward examining educational technology in what we see to be a complex social system.

In the brief time that I have, I would like to explore the notion of schools as sites of democratic struggle, schools as sites of political struggle. Political struggle here means having to do with competing ideological positions. Seeing schools as political institutions is not a mainstream understanding of the educational experience. But if we recognize schools as political institutions, we can begin to see them as "sites of possibility". By this I mean there is no one best system of schooling, and schools are places where the experience of community can begin to take place. Issues of social justice, the common good, equality, freedom, etc., are part of the American ideology, the view that America has of itself. This ideology is the foundation of what it means to build community. Community can exist only within a framework where these values are cherished.

The Need for Community

In talking about the need for community, I am talking about building community within the schooling experience. Foundations Symposia have always advocated reading texts outside the mainstream instructional technology literature. This literature presents us with different viewpoints regarding education that we can use to ask ourselves questions about our own work in technology. For example, when I read David Purpel's essay (1993) on "Educational Discourse and Global Crisis: What's a Teacher To Do?", he presents me with this statement: there is a major gap between "mainstream educational discourse and the urgent social, political and moral crises of our time" (p.278). What does this mean? Mainstream educational discourse is technical/instrumental in nature. This means that the language we use in talking about education has to do with a "scientific" rationality of cause/effect, means-ends relationships and it focuses on predictability, efficiency and control. Mainstream educational discourse focuses on educational reform that is seen as fine-tuning the system, and hence any incremental rearrangement of school practice is seen as substantive change. We keep fixing the existing system- e.g., teacher wages, class size reductions, adding services and programs, changing curricula, adding technology, etc., without substantive change in what school is about. In other words, school is teaching content, school is producing citizens.

Our mainstream educational language does not take into consideration the complex social/ political/economic reality , i.e., the sociocultural context. We have no open forums for debate concerning this complex reality. As a society, within the public sphere, we seem to have lost a working language and a desire to engage each other in substantive (moral) discourse about education. Our working ideas and understandings of democracy have become abstractions. Yet not engaging this world leaves our discourse incomplete, uncritical, simplistic. If we are to build "real" community (as opposed to "virtual" communities) we will need a way to engage each other in moral discourse. This will allow us to develop a language of democracy. We can begin to do this through a radical, critical praxisWhat is critical praxis, critical pedagogy? What is radical/critical education? Very briefly, when I read Henry Giroux's text Disturbing Pleasures: Learning Popular Culture (1992), Giroux states that radical/ critical education is not a specific "body of knowledge", but is rather a particular kind of practice and a way of "questioning received institutions and received assumptions". Critical forms of education are "interdisciplinary in nature", question the "fundamental categories of all disciplines", and have a "public mission of making society more democratic" (p.10). Paulo Freire refers to critical teaching as an "unquiet pedagogy" (1) that acknowledges student/teacher voice in the learning process. An unquiet pedagogy fosters and provides the opportunity for democratic schooling through confronting issues of social justice, the common good, equality before the law, etc. These issues involve the characteristics that are needed to work toward the creation of community (i.e. social justice, the common good, equality, etc.). Creating democratic community requires a different kind of discourse (other than a technical discourse), a moral discourse, which is a way to talk about what community is.

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Within the above discussion I am looking for ways for us to engage each other in a dialogue that will move us into areas that we can explore toward building community. My interest is in building community where we are, which is particularly true for me as an educator within an institutional setting that at times seems to be at odds with building a democratic, participatory community. The notion of building democratic, participatory community is important because, historically, our beliefs and actions toward democracy have changed. There is no one vision of democracy; visions of democracy have "competing interests" as well as differing notions of "social justice"; and because of our inability to engage in moral dialogue within society (especially within schools), it is increasingly difficult to clarify, debate or act on these visions, much less develop historical understanding. Question: do we, as a society, engage in dialogue regarding the larger issues? Is there a forum for such dialogue? Landon Beyer suggests "no". He writes in the essay "Schooling for the Culture of Democracy" (1988) that the inability of society (and the "schools") to provide a forum for open discussion/on-going dialogue results from

> ...a loss of communities within which such discourse can become meaningful and prompt the requisite social action. Surrounded by larger institutional structures favoring technization, commodification, and the therapeutic privatization of social relations, we have all but lost a sense of the collective social good so necessary for discussion of democratic ideas (Beyer, 1988, p.221).

In other words, the collective social good is replaced by individual pathologies, individual problems, separated from the social context. The idea of individuals "coping" with society masks, and allows, social reality to be unproblematic. Jean Elshtain agrees, and in her text Democracy on Trial (1995) comments on the loss of communities:

> "We are in danger of losing democratic civil society. It is that simple and that dangerous, springing as it does, not from a generous openness to sharp disagreement -democratic feistiness- but from a cynical and resentful closing off of others (p.xii)."

By civil society, Elshtain means the "many forms of community and association that dot the landscape of a democratic culture" (1995, p.5). She includes families, churches, volunteer groups providing "assistance to the needy", self-help movements, trade unions, etc. It is in these groups that the "democratic ethos and spirits of citizens are made manifest" (p.5). The "closing off from others" creates a void in these "civic spaces", and suggests the loss of skills and facility in face-to-face communication. (2) However, schools are also sites where this discussion can be fostered. Schools are public forums (face-to-face communication can and does happen), subject to public debate and dialogue. To take away this public forum, we take away the public discourse.

What happens when we take away this public forum? A void is created in these civic spaces, and it is filled by "someone". Elshtain (1995) suggests that

> once a world of personal responsibility with its characteristic virtues and marks of decency (honor, friendship, fidelity, and fairness) is ruptured or emptied, what rushes in to take its place is politics as a "technology of power," in Vaclav Havel's words (p.88).

Politics as a technology of power means that ideological forms of coercion seem legitimate because they are unquestioned, common-sensical, taken-for-granted views. Its effects are expressed in feelings of disenfranchisement, loss of a sense of being in control of one's life situation, and even a further withdrawal from the public sphere into the private. Thus, how can we engage each other in purposeful dialogue/communication regarding the possibilities of personal or social change, the nature of our experiences, the creating of visions that lead to increased democratic forms of participation in society, etc., if our public forums are fractured, dysfunctional? In other words, how do we talk with each other in democratic places?

The Need for Moral Discourse

The above discussion brings me back to the importance of moral discourse as an integral necessity of establishing a sense of community. As I stated at the outset of this essay, Purpel (1993) sees the need for a moral discourse within society generally, but within education specifically because of the dangerous chasm between "mainstream educational discourse and the urgent social, political, and moral crises of our time" (p.278) (3). Mainstream public debate both within and without education seems to center on technical (as opposed to critical) issues. Technical, instrumental educational discourse focused on technical issues should be of great concern to all of us who believe education offers possibilities for social change. I am not arguing that education is the prevailing force for fundamental social and cultural change. But I would argue that schools have a role to play.

Again, contemporary educational discourse is technical in nature. Technical and instrumental forms of educational discourse focus on "ameliorating" the existing system, i.e., seeing the system as something to be fixed or "fine-tuned" but not something to be transformed. Yet the urgent social, political, and moral crises of our time demand more than fixing/fine-tuning. These crises demand engaging in a moral discourse. Moral discourse for Purpel means not only "moral analysis", but also the task "must include forging a moral vision- one that can inform and energize our political will and educational strategy" (Purpel, 1993, p.282). I interpret moral vision as a utopian vision, in which "things could be different than what they are". This utopian vision provides us with possibility. In the language of Giroux (1989), we are moving from the language of critique to the language of possibility. Without critique and the vision of possibility, change becomes impossible. Without critique of existing school arrangements and visions of what school can be, substantive school reform is impossible. This is the meaning of schools being sites of possibility.

Developing a "moral vision" includes confronting "painful and anguishing dimensions of current educational practice" (Purpel, 1993, p.282). These practices have to do with the technical/instrumental concerns of schooling, which are important from a school management position, but leave untouched the more substantive issues of school reform. Purpel is quite specific here regarding the "painful and anguishing dimensions of current educational practice" and is worth quoting at length:

> Teachers are caught up in a system in which individual achievement, competition, success and aggressiveness are essential and central elements. It is a system in which education becomes an instrument in legitimizing and defining hierarchy; in which schools are a site where people are sorted, graded, classified, and labeled, hence giving credence to the tacit social value that dignity is to be earned. Teachers are asked to prepare students differently- some are to be given the encouragement and skills to be leaders, whereas others are taught to endure their indignities quietly and proudly. It is a system that helps sustain and legitimize a society reveling in consumerism, jingoism, hedonism, greed, and hierarchy" (p.282).

Moral vision must include "the problematics and limitations of the various reforms and critiques that range from criticisms of teachers working conditions and ways to basic curriculum reform" (p.282). What are we left with? What is an alternative?

Democratic Schooling

Purpel's critical stance outlined above is embodied within the following position on practice within democratic schooling, providing further meaning to the notion of schools being sites of possibility. In the ASCD publication Democratic Schools (1995), Michael Apple and James Beane outline "conditions on which democracy depends" and how these conditions have become the concerns of democratic schools:

1. The open flow of ideas, regardless of their popularity, that enables people to be as fully informed as possible.
2. Faith in the individual and collective capacity of people to create possibilities for resolving problems.
3. The use of critical reflection and analysis to evaluate ideas, problems, and policies.
4. Concern for the welfare of others and "the common good."
5. Concern for the dignity and rights of individuals and minorities.
6. An understanding that democracy is not so much an "ideal" to be pursued as an "idealized" set of values that we must live and that must guide our life as a people.

7. The organization of social institutions to promote and extend the democratic way of life. (Apple and Beane, 1995, pp.6-7).

Although it makes sense to have democratic schools with democratic practices if students are to be informed of such a way of life and government, and there is an educational history of such practices as well as renewed interest in the practice of democratic schooling (4), Apple and Beane (1995) state

> there is perhaps no more problematic concept in education than that of democratic schools, a concept that some consider almost an oxymoron. How can this be so? Simply put, many people believe that democracy is nothing more than a form of federal government and thus does not apply to schools and other social institutions. Many also believe that democracy is a right of adults, not of young people. And some believe that democracy simply cannot work in schools" (p.7).

Deborah Meier (1995) answers those who question whether or not schools can be democratic, those who question whether democracy is for the young. She argues that it's not a question of whether or not we can educate children well, but rather "Do we want to do it badly enough?" (p.4). Hence it will take active public interest and commitment to re-new the public discourse on education within the framework of democracy suggested above.

Meier (1995) states "Schools can squelch intelligence, they can foster intolerance and disrespect, they affect the way we see ourselves in the pecking order", and that is precisely the reason we cannot abandon public schools (p.6). In public education, students are united by "right", not "privilege". Rights are contested. This gets messy.

> Democracy is not always convenient, and rights do require sorting out. Neither equity, civil rights, nor mutual respect for the ideas of others are always the winners even in public institutions -far from it- but public schooling shifts the odds in favor of such democratic principles (Meier, 1995, p.7).

Public schools offer the possibility of developing a sense of community (schools as sites of possibility). Public schools put us face-to-face with others we might see as "statistics or categories" (the disenfranchised, students of different ethnic background, etc). Schools are places where we learn how to conduct ourselves in public ("for better or worse"). And public schools (as public forums) can provide the opportunity and practice for

> such political conversation across divisions of race, class, religion, and ideology. It is often in the clash of irreconcilable ideas that we can learn how to test or revise ideas, or invent new ones (Meier, 1995, p.7).

"The clash of irreconcilable ideas" is part of dealing with personal difference, and personal difference always makes things "complicated". Meier argues that dealing with the complicated is what education for citizenship is all about. "Ideas -the way we organize knowledge- are the medium of exchange in democratic life, just as money is in the market place" (1995, pp.7-8).

Meier rightly suggests that "Schools embody the dreams we have for our children. All of them. These dreams must remain public property" (1995, p.11). Purpel (1993) acknowledges the fragmentation and isolation that indicates a crisis in community (cf. Elshtain, and Meier above), but rejects the notion of a "common knowledge" that binds people together. Rather we need to "forge a greater share of community through a common moral vision" (p.283). This is what Meier refers to as the dreams we have for our children that must remain public property. I interpret this common moral vision as incorporating the American ideology, the American creed, which includes notions of the common good, social justice, equality of opportunity, freedom from discrimination, etc. We have a language that speaks of these values that America stands for, if not in actuality. In this sense, diversity and unity are not oppositional, but held together by a common ideological position. Here I am talking about the debates over multicultural education.

For Purpel and Shapiro (1995), the public discourse surrounding education is "...nothing less than the question of what kind of world we live in, what we wish it to become, and who are the innovators who may favor or obstruct such possibilities" (p.136). They argue that the public discourse about education, in relation to the broader questions regarding culture and society, usually have been treated with "varying degrees of obfuscation, denial, and mystification" (p.136). This has resulted in some asserting education's "moral and political neutrality", some arguing the importance of an "economic rationale for education (the 'human capital' view of the purpose of schools)," and the political right's position that "education act as a brake on the moral and cultural disintegration of the nation" (p.136).

An important discussion needs to take place here regarding the notion of structure and agency, i.e., the social context and individual autonomy within that context (the sociocultural context). While the current political climate suggests (advocates?) rugged individualism regarding responsibility for the conditions of one's life, suggesting that individual problems are individual pathologies, a sociocultural analysis suggests the individual cannot be understood outside of that social context. For example, the growth of poverty in the United States and the attendant conditions that work against individuals calls into question the very cornerstone of the American ideology, achievement and the notion of a meritocracy. As Purpel and Shapiro state

> Whether it be personal happiness, economic well-being, or social success and recognition, everything is supposedly in the hands of the individual. The pop-psychology formulation of 'Take responsibility for your own life' and 'You can make it if you really try,' he says, reinforces in new ways the cornerstone of American ideology, namely, the belief in meritocracy. If you want happiness, you will get it; if you don't have it, you have only yourself to blame" (p.137).

There are contradictory/competing ideologies our society works within. Sociocultural analysis could broaden the above discussion by raising questions about the ideologies, such as the "achievement ideology" and the notion of a meritocracy, or call upon other aspects of the ideology, e.g., the notion of social justice, equality of opportunity, the common good established through a sense of community, etc. (that set of values that help democracy flourish). Socio-cultural analysis could identify or raise questions regarding the ever-widening gap between rich and poor, the global economy, employment opportunities, minimum wage employment, loss of manufacturing jobs, etc., i.e., the current economic issues of today. This could allow us to break out of a position of rugged individualism, and recognize the interdependence of the "I and the we" (community).

Let me try to pull this discussion together.

Ideas about Democracy, Moral Discourse, and Educational Practice: Movement Toward Community

The notion of democracy can provide a foundation of values as well as an orientation for our work in education. These values revolve around issues of social justice, the common good, equality, freedom, community. These terms embody those broad problematic areas that sometimes go by the name of the "American Creed", or the "American Ideology".(5) These issues are problematic because they are not fixed in their meaning, but rather open to interpretation. To inquire into these issues requires a commitment to engage each other in moral discourse. This discourse must also be open to critique. To act democratically, to move from language to action, would require that we be guided by, to be informed by, that set of values. Again, I am talking about democracy as a set of values (the American ideology) as well as democracy as a site of struggle, establishing horizontal ties between citizen and citizen.

These values must be more than abstract principles, more than intellectual pursuits, but again, they inform our work. They become our orientation toward how we talk about community. Thus, there needs to be some involvement with the "political" notion of "civic education". (6)

This notion of democracy cannot be a-historical. As Giroux (1988) states, "Democracy is a 'site' of struggle and as social practice is informed by competing ideological conceptions of power, politics, and community" (pp.28-29). To develop a language of citizenship and democracy requires examination of the "horizontal ties between citizen and citizen". Here we are concerned with the notion of difference wherein the demands, cultures, and social relations of different groups must be recognized as part of understanding what it means to be a pluralistic society (cf Giroux, 1988, p.30). Thus "difference and identity" must be central to any debate regarding democracy and politics. This means that "theories of difference" are not only concerned with representation of identities (how the "Other" is represented), but also must be concerned with issues regarding relations of power (Giroux, 1994, p.58).

Identity here must be seen as "...the effect of social struggles between different communities over issues of representation, the distribution of material resources, and the practice of social justice" (Giroux, 1994, p.61). This understanding of identity exemplifies what is meant by democracy as a site of struggle.

What this means for education is that it is not enough to read the texts of the "Other". Wanting to know the "Other", Hazel Carby writes in "The Multicultural Wars" "... cannot replace the desire to challenge existing frameworks of segregation". She pointedly asks:

> Have we, as a society, successfully eliminated the need for achieving integration through political agitation for civil rights, and opted instead for knowing each other through cultural texts? (Carby, quoted in Giroux, 1994, p.59).

This again points to the political notion of citizenship and democracy as a site of struggle. For educators this means developing that set of values mentioned above that will inform our work.

The challenge for educators is how "to expand the basis for dialogue and community without erasing a politics of difference" (Giroux, 1994, p.59). Weeks states

> We may not be able to find, indeed we should not seek, a single way of life that would satisfy us all. That does not mean that we cannot agree on common political ends: the construction of what can best be described as a "community of communities", to achieve a maximum political unity without denying difference (quoted in Giroux, 1994, p.59).

I would like to conclude with a final comment on the notion of democracy being a site of struggle. Given the complexity of our society today, the global economy, our national economic outlook, legislation favoring corporate interests, minimum wage employment fueled by a service economy and the demise of the middle class in terms of living wages and loss of industry, the rich getting richer and the poor getting poorer and growing in numbers, the backlash against multiculturalism through a discourse of what Giroux (1994) calls "imaginary unities of common culture and national identity" (p.57; also cf Schlesinger, 1993), etc., these complexities exemplify what is meant by democracy being a site of struggle.

Recognizing that text-based media can become the basis for our public discourse and can help shape that discourse, we cannot confuse our creating and receiving texts through our keyboards with the struggle for democracy. Democracy is fought for face to face. Democracy is fought for over specific issues. The struggle for democracy is local, as local and specific as our workplace. Schools are sites of struggle, sites of possibility. As identified above, Apple and Beane's (1995) "conditions on which democracy depends" provide a substantive theoretical grounding for school practice, possibility.

Finally, it is in community, in the company of others, where our sites of struggle can make a critical difference. And as Elshtain (1995) reminds us,

> ...democracy is for the stout of heart who know there are things worth fighting for in a world of paradox, ambiguity, and irony. This democratic way -moderation with courage, open to compromise from a basis of principle- is the rare but occasionally attainable fruit of the democratic imagination and the democratic citizen in action. Democracy is on trial in our time, beleaguered by foes and bedeviled by friends. But there have always been skeptics (pp.89-90).

As educators, we cannot afford to be part of the skeptics. If schools really are the "conscious embodiment of the way we want our next generation to understand their world and their place in it" (Meier, 1995, p.135), it is imperative to know what that message/vision might be. And our generation will have succeeded in not permitting democracy to pass away as in a dream (cf opening quote to this chapter). And this must be done by the "real" as well as the "virtual" attempts at public education.

Endnotes

1. Freire uses the term "unquiet" to refer to critical and radical pedagogy: "A pedagogy is that much more critical and radical the more investigative and less certain of 'certainties' it is. The more unquiet a pedagogy, the more critical it will become" (quoted in Kutz and Roskelly, 1991) An unquiet, or critical pedagogy confronts our experiencing of the social-school-life world and acknowledges the possible contradictions. An unquiet/critical pedagogy is informed by and allows for the technical, practical and emancipatory forms of knowing within the learning process. This pedagogy confronts notions of cultural capital, achievement ideology and social reproduction, as well as the social construction of knowledge and how these are played out in schooling.

2. Meier (1995) also refers to the loss of democratic spaces: "The formal and informal institutions that were once accessible to the majority of children and that grounded the young in a society of responsible adults are missing for most, at precisely the moment they are most needed. Face-to-face meeting places such as political clubs, union halls, and settlement houses have all but disappeared. These were not only places of nurturance, but places where we learned skills, felt safe enough to take needed risks, learned to believe in the future. Only schools remain" (pp.9-10).

This is not a romanticization of the past, but a recognition that, for better or worse, our public spaces were diverse and represented the possibility for initiation and commitment into public life.

3. Beyer (1988) argues that we have lost our ability to engage each other in purposive dialogue i.e., we have "lost the ability to use moral language sensibly". Quoting Alasdair MacIntyre, in place of moral discourse,

> what we possess ... are the fragments of a conceptual scheme, parts which now lack those contexts from which their significance derived. We possess indeed simulacra of morality, we continue to use many of the key expressions. But we have -very largely, if not entirely- lost our comprehension, both theoretical and practical, of morality (Beyer, 1988, p.223).

Beyer (1988) attributes the inability to use moral language sensibly to forms of academic theorizing that have "weakened the authenticity and potency of moral discourse" (p.223). He discusses three such forms: First, conceptual analysis in philosophy which tends to separate moral debate from social context. This has to do with looking at "ideal types" which have the essential characteristics of the issue under discussion (e.g. notions of freedom, social justice, etc.). This form of conceptual analysis looks for refinement and analysis of word use/meaning in particular situations to clarify meaning. The end is to be more precise in what terms mean, in order to identify and correct ambiguous or incorrect usage. Secondly, a position of "epistemological and ontological" dualism with a commitment to certitude through forms of empirical investigation. The dualism "inherent in positivistic endeavors demeans the viability of moral judgments" (p.225). Here Beyer is referencing the over-reliance on positivistic forms of inquiry (empirical science) which claims objectivity, value neutrality, and an atheoretical stance. Within such a position "knowledge is to be found precisely by separating our observations and analyses from that untrustworthy social context from which, as Plato surmised, only opinion can spring" (Beyer, 1988, p.225). And, third, the university research community, as a community of scholars involved in the "conservation, development, and dissemination" of our cultural heritage, shifted their allegiance, becoming more closely allied with "social and governmental agencies, and responsive to the demands of the growing corporate sector". This had the effect of further separating moral discourse from "the production of knowledge", which production happened within increasingly narrow disciplines and sub-disciplines, while moral inquiry belonged to one area of academic inquiry (p.225), namely philosophy.

4. See, for example, Apple and Beane, 1995; Wood, 1992; Meier, 1995; Rose, 1995; et al.

5. The American ideology can mean meritocracy, rugged individualism and independence, etc. Yet there are other meanings as well. I include that strong set of values that "America" prides itself on: social justice, the common good and the building of community, equality of opportunity, etc.

6. This is the meaning of Apple and Beane's (1995) set of conditions that are part of democratic practice, especially the sixth one: "An understanding that democracy is not so much an 'ideal' to be pursued as an 'idealized' set of values that we must live and that must guide our life as a people" (p.7).

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SYMPOSIUM
Making Systemic Change in Education Work: Social and Historical Considerations

Critical Literacy, School Reform and Social Transformation

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My brief comments are concerned with the notion of critical literacy, school reform and social transformation. Much emphasis has been and continues to be placed on school reform, without much consideration or analyses of the social conditions/issues that affect change within educational settings. My main position is that our educational reform efforts are doomed to failure because we view educational reform/change in isolation from the rest of the system, seeing reform as technical change.

The mainstream discourse of education over the past sixteen years has been shaped by the 1982 publication of "A Nation at Risk" and the 1990 publication of "America 2000". The discussion generated from these reports has to do with fine-tuning education through incremental, technical changes, and intimates a causal link between the state of the economy and the work of the schools. The increasing call for "National Standards" for education, restructuring of schools, vouchers, privatization of schooling are part of the same search for a causal link. There is also the assumption that "the purpose of public education is to prepare Americans to compete, both as individuals and as a society, in the new global economic order" (Sehr, 1997, p.1). It is argued that raising standards, making education better, we will have a work force that will qualify for better jobs, higher wages, and America will prosper. However, searching/focusing on this causal link (in isolation from the larger sociocultural context) serves to mask, or divert attention away from the larger issues.

What are some of the larger issues? The increasing division between the haves/have nots; the demise of the middle class; the movement from industrial jobs to the proliferation of jobs within the service economy (minimum wage employment vs living wage employment giving rise to increasing numbers of workers being classified as the working poor); increased automation and downsizing in the workplace; one of the highest incarceration rates among industrialized nations; decay of our urban areas; etc. I conclude from this that our main discussion should not be on school reform, but about social transformation. The major problems facing our society today have to do with economic realities and deep social issues/problems. Schools exist within the larger social context/system (society). Schools may be part of the problem, but they are not the problem.

Schools are part of the problem when their efforts at change resemble fine-tuning the system without acknowledging the larger issues. Take, for example, the push toward defining excellence as measured by high standardized test scores. Politicians, reformers, the business community, have not been able to take the discussions of standards beyond students scoring well on tests. They have not been asked, nor have they volunteered, information as to what they believe will happen within our communities when the schools raise everyone up to the 90th percentile. What affect will that have on our communities? How will the quality of life within our communities change when we accomplish this feat? Will there automatically be more jobs available from which our students can chose? Will the economy take a sudden turn for the better in anticipation of the new, informed labor force? I contend the only reality known with any certainty about raising the test scores is that the test companies will change the tests, because the tests are not doing what they are supposed to do, namely, discriminating students along a normal distribution.

As cynical as the above may sound, I believe it is a valid critique of what we read in the mainstream press, and what all too much of the literature in education supports. As Shannon suggests (1993)

> ... the illusion that schooling is an economic anchor influences, if not directly affects, the immediate circumstances of schooling in profound ways. For example, extended school days, 'smartened up' textbooks, intensified curricula, and new calls for national standards and assessments are direct consequences of the promotion and power of these advocates and their illusions. Teachers who ignore this connection between classroom and social life are likely to be at a disadvantage when trying to participate in the restructuring of schools" (p.87).

Absent from this mainstream discourse regarding educational reform is any sense of schools as sites of democratic struggle regarding representation, voice, and action. Schools as sites of democratic struggle require participants to be able to read the word and read the world. Reading the word and the world necessitate an understanding of literacy that centers on critical readings of context "to expose false illusions" projected (the causal links mentioned earlier), "writing to set the record straight", and "action to demonstrate that schools could be places where teachers and students develop democratic voices in order to struggle against the realities of poverty in America" (Shannon, 1993, p.87). This notion of literacy is grounded in the language of critique which provides a discourse of possibility that could lead to substantive change. Hence, in order to have meaningful school reform efforts we need to create conditions wherein "...we can develop democratic voices at all levels of schooling so that together we can engage in an active public life" (Shannon, 1993, p.90).

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Meeting Software Needs of Public and Higher Education: A Collaborative Model

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Abstract

While collaboration between public schools and higher education is prevalent due to the Professional Development movements, one area of potential collaboration has been overlooked. This area consists of the need in public schools for educational software and the need in computer education for senior software design projects. This paper discusses the ongoing prototype of the Software Collaboration Model designed to meet the needs of both public and higher education. The model is based on instructional design principles and proposes that both public and higher education institutions can benefit through the collaboration of senior software design students and in-service public school teachers. Findings from the initial prototype indicate that the model needs to be modified, giving more attention to communication between all involved parties, instructional design, and allowing for revisions of each step of the process. Such modifications have been made and a revised model is suggested.

Rationale

The idea to develop a model for collaboration between in-service teachers and senior computer science majors emanated out of separate informal conversations with both parties. Although the conversations varied in perspective, the underlying theme (the need for software development) was the same. The in-service teachers wanted software developed specifically for their students' needs while the computer science students needed to develop a high quality software program. Given the common interest in software development and the complimentary nature of their needs, the possibility of collaboration arose.

To verify the potential for a collaborative model, it was necessary to investigate the needs of both parties and identify the benefits of a collaboration. Hence, an informal needs assessment consisting of individual and group interviews and a benefits analysis was performed. Both in-service teachers and senior computer science design students were assessed prior to the creation of this collaborative model.

In assessing the technology needs for public school teachers, in-service teachers from a rural middle school were the participants. Subsequent to the assessment, one obvious area of need that emerged was for relevant and affordable educational software. Most teachers indicated a lack of funding for software, software that is relevant to specific curricular needs, or both. This finding supports previous literature that suggest teachers and schools lack content-suitable software and/or funding for such software (Braswell, 1994; Oughton & Krawchuk, 1997).

In conjunction with the need for content-suitable software came the perceived need to improve math and science scores across the state. The teachers indicated that standard test scores were below acceptable national and state levels. These feelings were validated recently as the state SAT-9 test reported that over 60% of graduating seniors did not pass the math portion of the test. As such, during the interviews math was identified by the teachers as a content area in need of software assistance.

With the lack of funding and available software, teachers identified a third area of need. They reported that, although they are willing to use supplemental software in their classrooms, they are not capable of creating appropriate software due to time constraints and/or a lack of skills. While these concerns are cogent, the teachers' references to time and skills are not new and have been identified in previous research as areas of consideration (Golas, 1993; Maddux, 1994; Oughton & Krawchuk, 1997). In summary, the findings of the needs assessment on in-service teachers at a rural middle school revealed that these in-service teachers want math-related educational software that is inexpensive and content -relevant without having to create the time or skills necessary to develop it themselves.

The second stage of the needs assessment focused on senior software design students at a mid-sized public university. When assessing the senior software design students, two areas of need were identified. First, students were required to create an extensive software program as a final project in order to graduate. The students viewed this area as "THE" need. They felt as though all other needs were secondary due to the fact that their careers were determined by this one project. Thus, their primary focus was to complete a high-quality final project in a manner that allowed for their graduation.

Secondly, because of the high quality of these software projects, several students were interested in marketing their products. However, they felt they would encounter difficulty when trying to find subjects to Beta test their software products. They feared that they would be unable to find an adequate number of subjects as well as subjects that were appropriate for the content. To summarize, the needs of the software design students included the production of a high quality software program and the Beta testing of that program by adequate and appropriate subjects before marketing.

After examining the stated needs of these two parties, the potential benefits of a collaboration became apparent. The teachers could benefit from the collaboration by obtaining free and relevant math-based software programs for their students. At the same time, the software design students could benefit by meeting their degree requirements (producing a high quality program) and obtaining a subject pool for Beta testing of their program. Given the potential win-win outcome from a collaboration, the development of a collaborative model began.

Participants

Upon completion of the needs assessment, a team of software design students and an in-service teacher were chosen to work together on a software development project. The software design team consisted of three senior software design students. They were required to collaboratively create a high quality software program as a final project before graduation. They were also very interested in marketing their final product and wanted to focus on an educational program due to a large market for educational software programs. Both of these factors acted as strong motivators for the students to participate in this project.

The decreasing math scores and need for educational software motivated the in-service teacher to participate. She teaches 5-8 grade middle school mathematics students on a daily basis. She appeared extremely interested in attaining free and relevant software for her students and consistently indicated her need for computer-assisted instruction for her students. As such, she immediately became actively involved in this project.

Software Collaboration Model

While collaboration between in-service teachers and software design students appeared beneficial based on the initial needs assessment, precautionary measures were implemented. Before production began on the software development project, it was deemed necessary to assign tasks and specify roles. This was an attempt to prevent the needs of either party from being ignored, which could potentially foster animosity towards future collaboration and could hinder the completion of this particular project. As such, a collaborative model that takes into account such problems as role ambiguity and project coordination was developed specifically for this type of project (see Fig. 1). Descriptions of each phase of the model are detailed in the following section along with narrative describing the outcomes of each phase for this particular software development project.

Description

The Software Collaboration Model is based on traditional instructional design principles and is described in terms of phases (interest, equipment, etc.) but also considers the participants (software students, teacher). For each phase, participants have specific duties to perform or decisions to make. Just as a good instructional design model will lead to good instruction, when these phases are adhered to, it is postulated that the result will be a final product that benefits all parties involved. However, if at any time during the project the needs of one of the parties are not being met and a resolution does not occur, it is suggested that the collaboration be terminated. Without an end product that benefits both parties, the collaboration does not serve the intended purpose and the use of the model is nothing more than a formality.

Interest

The first phase of this model is critical to the successful completion of a product. The first phase is entitled "Interest" and involves two separate tasks. The first task is to identify the roles of the participants. According to traditional instructional design principles, it is crucial to identify the roles of those participating in the instructional design process (Dick & Carey, 1996; Kemp, Morrison, and Ross, 1994). Once roles are determined and agreed upon, there is little to no ambiguity as to the purpose of each participant throughout the process.

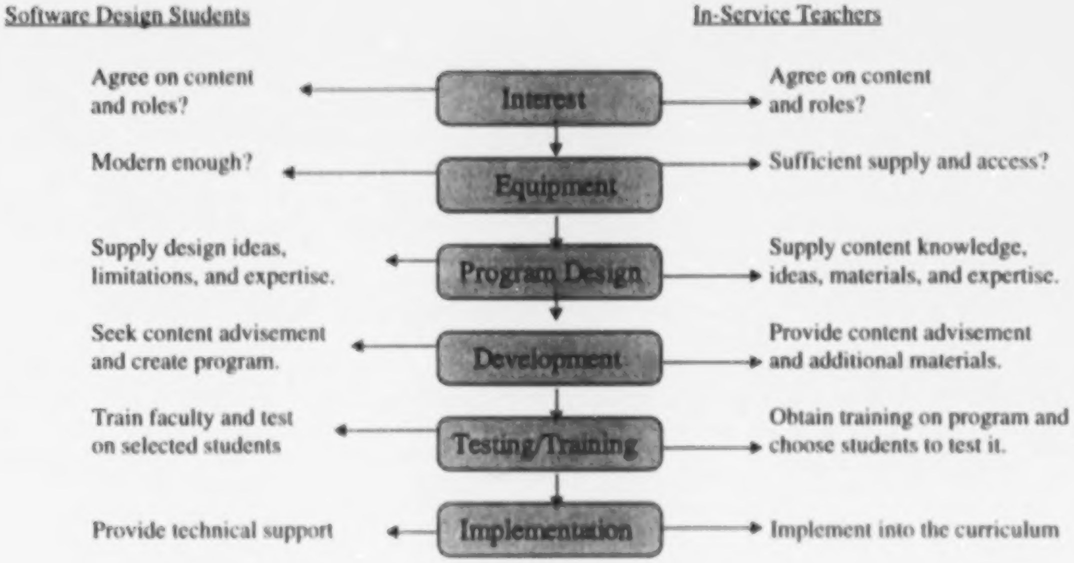
Software Design Students
In-Service Teachers
Agree on content and roles?
Interest
Agree on content and roles?
Modern enough?
Equipment
Sufficient supply and access?
Supply design ideas, limitations, and expertise.
Program Design
Supply content knowledge, ideas, materials, and expertise.
Seek content advisement and create program.
Development
Provide content advisement and additional materials.
Train faculty and test on selected students
Testing/Training
Obtain training on program and choose students to test it.
Provide technical support
Implementation
Implement into the curriculum

Figure 1. Software Collaboration Model

For this particular project, an introductory meeting was held to assign roles. The teacher was identified as the content expert and the software design students as the programming experts. It is no coincidence that the outcomes of this task mirrored the identification of subject-matter experts and media specialists, tasks identified in the instructional design models created by Kemp, Morrison, and Ross (1994) and Dick and Carey (1996).

The second task involved in the "Interest" phase includes the identification of the content to be used. Because this is a project that is to benefit both parties, both parties must be interested in developing the same content area. This step is very similar to the specification of content step in the Gerlach & Ely Model (Gerlach & Ely, 1980) and the identification of needs and goals step of the Dick and Carey Model (Dick & Carey, 1996).

Essentially, the purpose of this task is to identify the needs of both parties and specify the content area that will meet those needs. The content area that was specified in the introductory meeting for this specific project was 6th grade math. This content area was particularly important to the teacher, but was also an area in which the software students felt they could market their program.

Equipment

Because the instruction being considered is computer-based, the second phase of this collaborative model involves the identification of and access to sufficient equipment. Design models developed for computer-based instruction by Hannafin and Peck (1988) and Tripp and Bichelmeyer (1990) assert that the identification of computer resources is an essential aspect to the design process. As with those models, this particular model forces the participants to identify and recognize limitations that equipment may have on instructional development.

In this particular project, the design students toured the school and determined that the equipment in the school was modern enough to run the type of program that they needed to produce. At the same time, the teacher examined the computer lab schedule and determined that she had a sufficient supply of computers as well as adequate access. As a side note, had either of the participants felt that their needs were not being met due to equipment constraints or varying interests, the software project would have ceased at this point.

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Program Design

As with the "Equipment" phase, the "Program Design" phase needs to consider the limitations of the media. However, other design limitations must also be considered at this point. In order to accomplish this, the subject-matter expert (teacher) and media experts (design students) must collaborate to determine the feasibility of several design options given the chosen content area. This phase is similar to the step in Dick and Carey's (1996) instructional design model where the selection of instructional materials and development of instructional strategies occurs. In essence, the specific focus of this phase is the mental creation of what the instruction will look like when finished, taking into consideration equipment, programming, and content limitations.

The specifics of this phase for this particular project are detailed and lengthy. Therefore, the report on this section is somewhat abbreviated. In this particular phase, the teacher became the center of attention as she supplied the content materials and expertise in the content area. She discussed several math units that could be covered and provided presentation ideas, instructional methods, and materials to the software design students. The students, along with the teacher, discussed the ideas while taking into consideration programming abilities and time limitations. In the end, specific units were determined and the teacher provided books and resources to the design students. Presentation and instructional methods were also determined for each unit. Both the teacher and the design students brainstormed potential methods and when they were finished, everyone had a concrete mental picture of what the instruction would look like when complete.

Development

While the subject-matter expert (teacher) is the center of attention in the previous phase, the media experts (design students) are the center of attention in the "Development" phase. During this period, the media experts are charged with the task of actually creating the computer-based instruction, while the subject matter expert (teacher) provides content advisement and any additional materials that are needed. This phase is in accord with the design phase described in the Rapid Prototyping Model (Tripp & Bichelmeyer, 1990) and the development phase of the Hannafin and Peck CAI Model (Hannafin & Peck, 1988). Ultimately, the outcome of this phase is a prototype program ready for testing.

During the "Development" phase of this particular project, several activities occurred that hindered the remaining project phases. First and foremost, the media experts (students) found that they were quite the optimists when designing the program and had not been realistic in some of their design decisions. Because of the linearity of this collaborative model, there were no opportunities to go back to previous phases and revise. Thus, the students felt as though they were constantly rushed during the production of the computer software and, as such, did not produce the level of quality that they had anticipated.

The second barrier that appeared during this phase was one involving communication. Up until this point, each phase was addressed in face-to-face meetings between the teacher and the design students. However, once development began, the meetings ceased to occur and communication was limited to e-mail. As students found that they needed more content resources than was initially provided by the teacher, they attempted to contact the teacher via e-mail. Because the teacher was not a regular user of e-mail and did not respond immediately to their requests, the students felt as though their progress was impeded due to the lack of communication with the teacher.

The aforementioned factors, when combined, led to a feeling of non-cooperation and frustration on the part of the media experts (students). As such, the students decided to fore-go the use of the subject-matter expert (teacher) and continue the development on their own. Hence, as was discussed at the beginning of this model, one party felt that their needs were not being met and, accordingly, the project as whole was dissolved.

Testing/Training

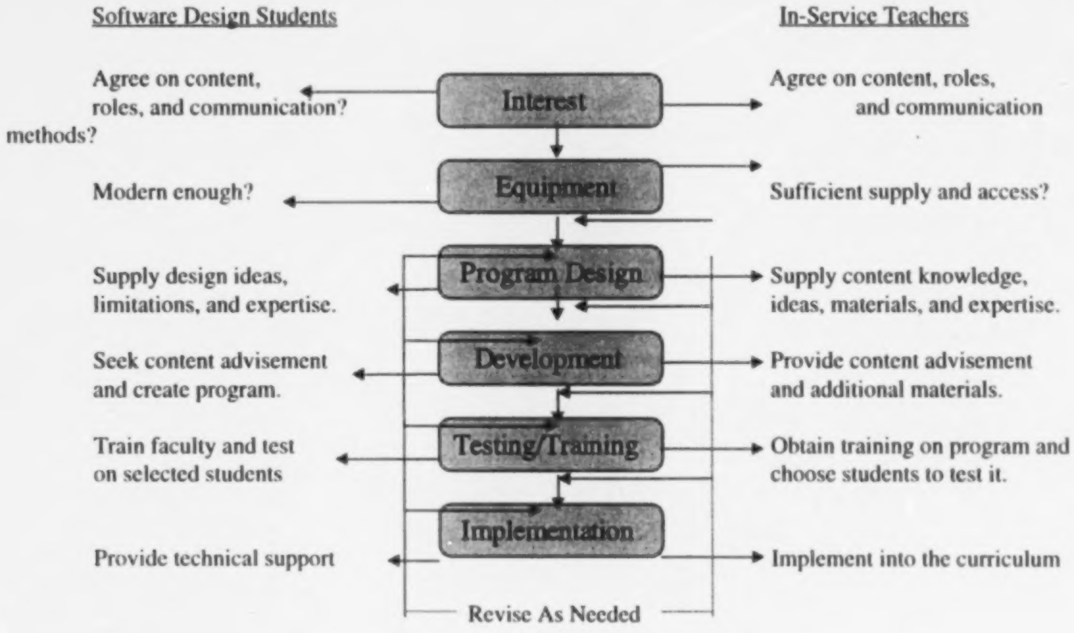
The "Testing/Training" phase of the Software Collaboration Model involves the testing of the program and the training of the teachers. This closely resembles the phase in the Rapid Prototyping Model (Tripp & Bichelmeyer, 1990) where the product is prototyped and researched. The task of the design student during this phase involves the training of faculty who plan to use the new software. The design students are also responsible for testing the program on selected students to help identify potential problems. Those students are chosen by the teacher, who is also responsible for receiving training on the new software at this time. Essentially, the outcome of this phase includes a trained teacher who can utilize the program and a prototype session in which potential problems are identified and fixed before the actual implementation. (Due to the fact that the design students in this particular project chose to dissolve their involvement, specific data for this phase is not available.)

Implementation

The final phase of the collaboration model involves the mass implementation of the program into the curriculum. The task of curriculum integration rest with the teacher, as does the scheduling of the computer lab. At this point, the primary task for the design students is to become a provider of technical support and assistance when needed. The design students may also take this opportunity to gather Beta data concerning their program. This phase most closely resembles the task in the Rapid Prototype Model (Tripp & Bichelmeyer, 1990) known as the "Install and Maintain System" step. (Due to the fact that the design students in this particular project chose to dissolve their involvement, specific data for this phase is not available.)

Revisions to the Model

Based on the results of the initial prototype project of the Software Collaborative Model, specific revisions have been recommended and implemented. First and foremost, the need for continual adaptation and revision of each phase is a necessity. Because the previous model lacked the revision process, the software design students felt undue pressure to adhere to content decisions that were made during the design phase even though they were found to be impractical during the development phase. To adjust and allow for revisions, the model has been updated and now includes a revision process at the design, development, testing/training, and implementation phases (see Fig. 2).


Software Design Students
In-Service Teachers
Agree on content, roles, and communication? methods?
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Equipment
Sufficient supply and access?
Supply design ideas, limitations, and expertise.
Program Design
Supply content knowledge, ideas, materials, and expertise.
Seek content advisement and create program.
Development
Provide content advisement and additional materials.
Train faculty and test on selected students
Testing/Training
Obtain training on program and choose students to test it.
Provide technical support
Implementation
Implement into the curriculum
Revise As Needed

Figure 2. Revised Software Collaboration Model

The second revision to the Software Collaboration Model involves communication. Rather than address methods of communication in the initial "Interest" phase, the topic was overlooked and eventually led to the disintegration of the prototype software design project. To prevent such an instance from occurring again, a task has been added to the "Interest" phase (see Fig. 2). Initially, the two tasks of the interest phase included agreeing on content and roles. The revised model adds the task of predetermining communication methods to this phase. By predetermining the methods to be used, participants utilizing the model may encounter less difficulties with the communication process.

The third and final revision that is undergoing consideration involves the instructional design component of the model. During the "Program Design" phase, the present model relies on the knowledge of both the teacher and the software design students to ensure that appropriate instructional design procedures are followed. However, it is proposed that the involvement of a third party who specializes in instructional design may enhance the instructional quality of the final produced program. At the present, the current author is experimenting with this idea by adding a

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masters level instructional technology student to the project. The benefits for both the instructional technology student and the final software program are currently being explored, but have yet to be added to the model. If successful, this aspect will be added to the Software Collaboration Model.

Conclusion

This paper has briefly described the needs and benefits of a collaboration between senior software design students and public teachers. Based on those needs and benefits, the Software Collaboration Model, which mirrors aspects of traditional instructional models, was developed. To test the collaborative model, a group of software design students and a teacher were chosen to participate in the collaborative development of a software design project. The results of this prototype project that attempted to utilize the Software Collaboration Model was reported. From those results, the areas of communication, revision, and instructional design were identified as potential areas in need. A revised version of the model was developed and described that took into account two of these three areas. At this point, the call is for future prototyping and, if necessary, future revision to the model.

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Learning in Open-Ended Technology Environments: Problems and Issues

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Abstract

Contemporary computer-based environments use the capabilities of technology to create contexts which require and afford students the opportunity to engage in authentic problem solving by generating, testing, and revising hypotheses; exploring and manipulating components of the environment; and representing and reflecting on what they know. By design, such environments require sophisticated levels of cognitive functioning including higher order cognitive and metacognitive functioning. Learning in open learning environments relies on a shared, reciprocal, and co-constructed understanding of events between the learners and the learning environment. The purposes of this paper are to critically analyze problems and issues related to learning with open, technology-based environments.

Open-ended, learner-centered environments are designed to support individual intentions to construct personal meaning by engaging in authentic projects or solving problems. The philosophical and theoretical assumptions of student-centered learning are fundamentally constructivist and situated (Jonassen, 1991; Hannafin & Land, 1997). Methods for supporting personal knowledge construction, such as problem-based learning (Savery & Duffy, 1996), anchored instruction (Cognition and Technology Group at Vanderbilt, 1992), situated cognition (Brown, Collins, & Duguid, 1989), project-based learning (Blumenfeld, et al. 1991), and open learning environments (Hannafin, Hall, Land, & Hill, 1994), share those constructivist and situated assumptions about learning and aim to provide contexts and structures that support meaningful, learner-centered interactions.

In concert with these methods, technology is often employed as a tool or mediator of the process, functioning as cognitive tools for experimentation, manipulation, and generation of ideas. The result is a complex, reciprocal interaction of learning *with* technology: tools, resources, and scaffolding facilitate actions that augment thinking, and meaning is built upon, and governed by, the results of these (learner-driven) actions (Salomon, Perkins, & Globerson, 1991. Achieving these results, however, requires continual evolution and sharing of meanings within the learner-technology partnership. The purposes of this paper, then, are to clarify (1) the theoretical assumptions that underlie learning with open, technology environments; (2) limitations in adaptive capabilities of technology; (3) the significance of two-way, shared understanding; and (4) problems and issues that can arise during the co-construction process.

Learning with Open Learning Environments: Processes and Assumptions

OLEs are technology-based environments that require learners to deploy unique knowledge and skill to solve complex and authentic problems (Hannafin, Hall, Land, & Hill, 1994). They use the capabilities of technology to create contexts wherein complex concepts can be represented, manipulated, explored, and revised. Rich information resources and computer-based tools are woven into contexts that create virtual spaces to support problem-solving and higher-order thinking. Examples of OLEs include computer-based microworlds (see Microworlds Project Builder, 1993); resource-based hypermedia environments for researching and linking ideas such as cognitive flexibility hypertexts (Spiro, Feltovich, Jacobson, & Coulson, 1991); and collaborative knowledge construction environments for sharing and linking of evidence, questions, and products (Linn, Bell, & Hsi, in press). OLEs foster development of understanding by providing opportunities for learners to identify, test, and revise ongoing theories as they solve complex problems and integrate multiple perspectives (Land & Hannafin, 1996).

The centrality of the learner in defining meaning is considered a necessary requirement for combating problems of over-simplified (Spiro, et al., 1991), "compliant," (McCaslin & Good, 1992) and decontextualized thinking (Cognition and Technology Group at Vanderbilt, 1992). Understanding is assumed to be best supported when it is rooted in personal experience and is accomplished via exploration, interpretation, and negotiation (Hannafin & Land, 1997). According to Land & Hannafin, (1996) understanding evolves continuously and dynamically, as ideas are generated, tested, and revised.

While assumptions and theories of student-centered learning are provocative, many questions remain about the efficacy of such environments, specifically those that are technology-based. For example, evidence indicates that learners do not always use open systems in ways that support knowledge construction, so they fail to evolve conceptions significantly, and may not use the *affordances* of technology to develop meaningful understanding (Atkins & Blissett, 1992). Rather than engaging in reflective learning, learners often deploy random instead of reason-based actions, search for "answers" instead of generating and testing problems (Wallace & Kupperman (1997), and sustain naive beliefs (in the face of repeated conflicting evidence) instead of evolving them (Land & Hannafin, 1997). Perkins (1985) has warned against the notion of a "fingertip effect" -- an over-reliance on assumptions about what an environment *can* afford -- in that the existence of an opportunity does not imply that it will be shared or engaged.

Explanations for the lack of effectiveness include limitations of the system to adapt to student needs, unanticipated implementation requirements of teachers, and a lack of empirical grounding for selected approaches, methods, or desired outcomes (Hannafin, Hannafin, Land, & Oliver, 1997). Additionally, a host of psychological and motivational variables may also impact understanding in open systems. In order for meaningful learning to occur, systems rely significantly on the intentions, actions, processing, and regulation mechanisms of the learner. Regardless of contexts or content domain, learners must assume primary responsibility for the learning process. This charge *requires* them to derive goals and problems, make informed decisions, take reason-based actions, process information and feedback, and monitor their needs and approaches on a meta-level. Furthermore, in order to continually evolve conceptions, learners must derive interpretations, test them for their validity, and evaluate their utility in light of confirming or conflicting data. These requirements for effectively functioning in learner-centered systems are demanding and exacting and not typically possessed by students. Yet, assumptions dictate that learners are not only capable of meeting such psychological requirements, but they are also imminent when supported by the system context.

Co-Construction with Technology: Issues in Adaptability

A fundamental premise of constructivist learning is that learners evolve understanding as a direct result of encountering "discrepant events", failed goals, unmet expectations, problems, curiosities, or cognitive dissonance (Piaget, 1976). This implies that learners naturally develop understanding of the surrounding environment by attempting to make sense of it and reconcile deviations from expectations. Yet, clearly there are also instances where "natural teaching" -- a reactive response to student needs when understanding is arrested -- is also effective for guiding students to a more refined conceptual level (Schank & Cleave, 1995). The zone of proximal development implies that meaningful learning occurs as a result of learner engagement in activities that are "scaffolded" by social, material, or technological faculties (Vygotsky, 1978). Thus, the development potential of learners is extended with the help of dynamic support that assists them in building upon initial understanding. However, the learner's ability to perceive and act upon a "need to know," as well as the environment's ability to respond to these needs, are critical to realizing effective interaction within the zone of proximal development.

Yet, re-directing, responding to, or meeting learner-generated needs within the theoretical "zone" is often problematic for technology-enhanced environments. One reason for this difficulty is that explicit, a priori identification of expected student needs are difficult to predict and thus fulfill. Whereas general scaffolding can be provided (e.g., help resources, instructional support, guiding questions, hints, or prompts for reflection), truly dynamic or "intelligent" responses to unique issues, interpretations, or questions may not be possible to satisfy through technology support alone. Potential difficulties are exacerbated when learners deploy idiosyncratic preferences and approaches that are not supported (nor sometimes desired) by the design (e.g., searching for a right answer vs. using tools to experiment). When learners' goals are dissonant from system goals, interactions become distorted, and the environmental support is counterproductive.

Limitations in adaptive capabilities of OLEs are significant for several reasons. First, the building and evolving of learner understanding is contingent upon feedback that is correspondingly contingent upon learner actions. The environment affords cognitive performance only when learner intentions and perceptions are consonant with system goals. With microworlds and simulations, for instance, learners must construct a "working model" of their understanding that is progressively honed via manipulation of system features. Through interaction, learners make their ideas explicit and clarify and extend both their understanding and implicit models (Driver & Scanlon, 1988). Feedback about the efficacy of the model is essential for critical examination, reflection, and conceptual development. As intentions and actions are increasingly linked with the feedback (and subsequent processing of the feedback), understanding is generated and examined critically.

Second, the importance of adaptive feedback becomes even more critical when learners maintain naive beliefs and fragmented understanding that are extremely resilient to change (Chinn & Brewer, 1993). Furthermore, they are *expected* to hold naive theories that will be represented in their actions and in their intentions to test their validity. Yet, evolving enduring beliefs requires repeated exposure to counter-examples that indicate how existing beliefs are limited in explanatory power (Karmiloff-Smith & Inhelder, 1975; Piaget, 1976; Vosniadou, 1992). Schön (1983) notes: "Doing extends thinking in the tests ... of experimental action, and reflection feeds on doing and its results...It is the surprising result of action that triggers reflection..." (p. 280). Thus, the system must be able to "understand" formative theories-in-action, represent the consequences or effectiveness of them, and provide responsive data that can be *perceived* as consistent or inconsistent.

Yet, even when the system provides responsive feedback about learners' models, if they fail to relate that feedback to their theories, they may not perceive how data support or contradict their beliefs. Intuitive theories (e.g., impetus theories of force and motion [Driver & Scanlon, 1988], beliefs that the Earth is flat, and beliefs that density is not a factor in the buoyancy of an object) are so consistently reinforced through personal experience that they form the foundation of firmly-established, though often fundamentally flawed, theories. In some cases, underlying beliefs are so entrenched that learners fail to consider testing them. If one truly believes that heavier objects sink and lighter objects float, for instance, it is unlikely that one will intentionally seek out opportunities to prove it wrong.

It is unlikely that problems in meeting the requirements or assumptions of student-centered learning happen unilaterally, i.e., that the locus of the problem lies solely within the learner (i.e., he or she is incapable of representing meaning or accurately perceiving feedback) or solely within the system (feedback is incapable of accurately modeling learner understanding or responding to individual needs). Rather, it is more likely that breakdowns occur as a result of distorted *interactions* that occur. Thus, the success of a constructivist environment hinges upon a shared, reciprocal, and co-constructed understanding of events and *intended* meanings during critical or teachable moments. That is, in order to build upon understanding in meaningful ways, perceptions, intentions, approaches, interpretations, questions, and feedback must be *understood* or *shared* among participants. This assertion defines critical components of the process of progressive negotiation and differentiation of meaning: learners must generate understanding that is based upon existing beliefs as well as responsive feedback from the system (and/or others); the system must then represent or model the intended interpretation and provide feedback regarding its efficacy; the learner must then perceive the intended meaning of data or feedback and refine interpretations. The cycle continues until learners identify beliefs, test them for their validity, and evolve them based on responsive feedback and scaffolding from the system. Thus, in order to support reciprocity and sharing of meaning, both models must be adaptable or are able co-construct. In this sense, meaning is based upon a *shared* overlap of understanding between the learner and the system.

The remaining sections detail issues related to the notion of *shared meaning* in constructivist, technology-based systems and identify potential sources of misunderstandings.

The Importance of Shared Meaning

Shared meaning assists both the learner and the system (or instructor or other learners) to increase the accuracy of, or decrease the potential distortion of, the co-construction process. Most teachers know all-to-well how easy it is for misunderstandings to take place. It is not uncommon to hear statements from learners such as "I thought you meant ..." or "I didn't realize what you meant by ..." or "I assumed that this meant..." when recognizing that misunderstandings have occurred. Upon receiving such feedback, most teachers can adapt their teaching or communication methods to clarify the meaning, redirect the student's understanding, or to circumvent similar misunderstandings from taking place in the future. Engaging in two-way conversations allows both participants to check to see if they are understanding each other and recast or revise explanations accordingly.

Shared meaning with OLEs implies a *functional* relatedness between a set of meanings and messages shared by both the learner and system. This does not imply that meanings are communicated isomorphically; rather, that important components of one message are received and used as the basis for response by the other. There is no "one way" to respond or make sense of a meaning. There is simply a congruence among all messages. In essence, shared meaning is process that ensures that the system and the learner are operating on the same "page" or on the same collection of meanings.

In action, the concept of shared meaning involves a dialectic or dynamic communication of meanings. Messages are continually sent back and forth, as learners perceive important variables, generate hypotheses, and test for their veracity. When learners communicate messages to the system through the interface, the system is programmed to respond to them. For instance, if a learner is exploring the effect of interest rate on monthly housing payments and increases the interest rate, the system processes it and returns a message that is based upon the initial input. That is, the system sends a message about the change in calculated output based upon the learner's request to increase the interest rate. The learner then uses this message as the basis for revising an interpretation, generating a new hypothesis, or confirming an expectation. The system response should always be contingent upon the learner's original meaning and modeled to the learner. Then, a collection of new meanings or responses are generated by the learner, yet they must be built upon original meanings and also accommodate the system's message. The cycle is repeated over time, with every message being used to refine a preceding one, until the learner decides to end the interaction.

The shared meaning process is significant in that it lies at the root of many assumptions about how understanding evolves with OLEs. It is assumed, for instance, that the learner can represent and communicate a meaning to the system. It is further assumed that the system can interpret the meaning, model it, and represent a response that can be discerned by the learner. Finally, it is assumed that the learner will accurately perceive, understand, and appropriate the message sent by the system, without altering its intention or ignoring it altogether. These are high expectations, particularly when considered in light of the fact that a machine cannot understand a message that it has not been programmed a priori to process.

Rather than judging the "correctness" of learners' responses, the system seeks convergence of system and learner models. Initially, learner models may be quite distinct from how they ultimately develop. Yet, through interaction with the system, initial and desired models become more aligned with each other within an acceptable range of confidence as defined by a community of practice.

As such, shared meaning should not be considered as a *goal* in and of itself. A tape recorder, for instance can accurately model or report exactly what has been dictated; yet a tape recorder does not understand. Rather, shared meaning is a necessary and important *means* toward increasing both partners understanding of each other's point of view at important points during the interaction. It is intended to emphasize theoretically the need for both the learner and the system to occupy a mutual and as complete understanding as possible of the other's intended meanings. This does not imply that complete understanding of all of the possible meanings of the system nor all of the possible meanings of the learner are either possible or desired. But, it is assumed likely that en-route interactions between the system and the learner will result in a progressive negotiation and development of understanding. Shared meaning is important for open systems because, when it occurs, interpretations can move forward from a point of understanding versus from a point of misunderstanding.

Sources of Misunderstanding

When the shared meaning process breaks down during open-ended learning, distortions in approaches, perceptions, or interpretations result. The purpose of this section is to illustrate where and how such points of departure can occur. While it is likely challenging or unnecessary to foster complete sharing of meaning for all possible learner-system interactions, specific types of interactions at critical points in the process can seriously impact the extent to which meanings evolve.

Perceptual Limitations of Visual Cues

Meaning is shared in instances where learners connect system data with personal meaning, and subsequently expand ways of explaining phenomena. As a result of the exchange, informal understanding becomes more clearly connected to the experiences that informed them and to formalized concepts. Accordingly, system and learner models are continually refined and merged. Yet, as messages and intended meanings are exchanged, two processes are essential for them to be shared. First, intended meanings must be accurately perceived by the learner and/or the system. Second, observed data must be accurately appropriated with interpretations that are constructed. For instance, if a learner virtually manipulates the effect of mass on an object's acceleration, and the system provides feedback indicating that the increase in mass did not increase its acceleration, it is essential that the learner is able to *perceive* that acceleration has not increased. Furthermore, if the learner concludes from that feedback that two objects of different masses will fall to the Earth at the same speed, he or she has constructed a meaning that is consonant with the message sent by the system and is linked to empirically-based observations. Breakdowns in either the accurate perception or appropriation of system messages can result in distorted conceptions. In order for understanding to evolve based on shared meanings, learners must induce personal models to unify multiple system concepts, accurately connecting factors and influences into wholes versus parts.

The ability to draw accurate conclusions based on empirical data is integral to scientific inquiry (Roth & Roychoudhury, 1993). Similarly, during the shared meaning process, learners must also stay proximal to the data -- i.e., system feedback is accurately perceived and acted upon and *related* meanings are used to annotate and understand the data. Drawing conclusions based on accurate perceptions is critical because understanding is initially built as learners attempt to make judgments regarding cause and effect (e.g., "when I decreased mass, there was no change in acceleration"); Understanding evolves as learners perceive information inconsistent with a theory (e.g., "I expected that the heavier object would fall faster but it did not"), provide an explanation, and collect data to confirm or refute it. Thus, the process of both building and evolving meaning is contingent upon *accurate* perception and connection of data and events occurring in the system (accuracy is defined as the *intended* meaning of the message sent by the system).

However, limitations in perceptual processes can lead to problems in establishing cause-effect relationships or to the development of conceptions based upon faulty presumptions. Rieber (1995), for instance, details a story of Percival Lowell, a prominent astronomer at the turn of the century, who serves as an example of how inaccurate visual perceptions can lead to erroneous conclusions. Using the telescopic technology available at the time, Lowell reported the spotting of long crossing lines on the Martian landscape. Lowell concluded from these observations that the lines were the remnants of canals constructed by an ancient civilization. Unfortunately, his perceptions (and consequently interpretations) were inaccurate, in that the canals turned out to be optical illusions.

This same type of analysis can also be applied to learners using visualization tools in open environments, due to the use of visually-based feedback that is often presented with ambiguous meaning or fidelity. OLEs often use dynamic displays of numerical data or animation to represent visually the effects of a learner's actions, rather than directly tell the meaning and interpretation of events. Many simulations or visualization tools such as *Space Shuttle Commander, ErgoMotion, Geometer's Sketchpad,* and *Interactive Physics* model the effects of learner input or designs via animated and/or video simulations (Rieber, 1992; 1995). The visually-simulated outcomes provide data regarding the extent to which learner designs functioned and/or changed. From this feedback, learners refine conjectures and hypotheses and confirm or refute expectations.

To illustrate, a learner attempting to maneuver a spacecraft in *Space Shuttle Commander* can see the result of applying a lighter mass to the spacecraft by watching it move across the screen and comparing it to the animated results of applying a heavier mass. Yet, following this animated feedback, the learner might inaccurately *perceive* that the spacecraft moved faster when he or she applied a lighter mass. The fact that the object may *not* have increased in speed contingent upon mass is inconsequential to the fact that the learner perceived that it did in fact accelerate. In this instance, the message conveyed by the system (i.e., mass did not impact acceleration) was not shared by the learner; rather it was confounded with inaccurate perceptions of visual information (i.e., it went faster when I decreased mass). From this initial misperception, it is not implausible to expect that distorted conclusions would likely follow.

Utilizing less visual forms of feedback, such as illustrating changes in numerical values, may not alleviate the tendencies of learners to rely heavily on visual cues as the basis for information. To illustrate, numerical data are often provided to learners in concert with animated, simulated feedback. Yet, Land and Hannafin (1997) reported that learners heavily relied upon video simulations of a roller coaster to judge relative differences in its speed, and failed to seek numerical data to confirm the speed, even when they were available in the form of data points. In this example, judging precise differences in speed was not possible using visual data alone. Thus, most errors in interpretation were due to inaccurate perceptions of visual data from the system, without deeper processing of the numerical data that could have been used to confirm or challenge meaning.

A reliance on literal interpretation of visual cues is likely due to novice learner's focus on superficial or surface features of a problem (Chi, Glaser, & Rees, 1982). Novice learners tend to confuse visibility with relevance and apply little consideration to the underlying logic of their selection (Petre, 1995). Thus, perceptual limitations of learners can affect the "pragmatic precision" (Hawkins & Pea, 1987, p. 296) or degree of exactitude sufficient for explanation. But, while novices may not require precise sources of evidence in order to establish meaning, they nonetheless *use* what they perceive. This phenomena is known as *top-down processing* -- "initial information triggers an early interpretation against which all subsequent information is judged" (Rieber, 1995, p. 53). In instances where learner perceptions conflict with meanings intended to be conveyed, misleading attributions of cause and effect result that become difficult to further test, alter, or refine. Misunderstandings can further endure in the likely event that the system is unable to detect that faulty perceptions have been constructed.

Biased and Confounded Meanings

Distorted conceptions are not solely apparent as a consequence of misperceived visual data. Learners are also susceptible to the effects of biased, preconceived, or deeply entrenched intuitive beliefs that can influence the precision with which messages are perceived or the likelihood of existing beliefs to change (Driver & Scanlon, 1988). Meanings are filtered through existing beliefs and experiences, and they become distorted when learners add to, ignore, or change system messages to fit existing conceptions (without evaluation). When this phenomena occurs, learners perform the cognitive equivalent of "seeing what they want to see." Thus, the issue for open learning environments is not that learners hold strong beliefs that are at odds with those represented in the environment; on the contrary, novice learners are expected to hold naive beliefs. Rather, problems occur to the extent that messages are altered or distorted to fit into existing belief systems, without evaluation of whether the data provides evidence to the contrary.

Wilson and Brekke (1994) refer to this phenomena as "mental contamination" and define it as "the process whereby a person has an unwanted judgment, emotion, or behavior because of mental processing that is unconscious or uncontrollable." (p. 117). This psychological mechanism results in automatic attributions of meanings that are useful during new learning -- it helps learners to quickly make order out of disorder. Yet, in order for naive beliefs to evolve in open systems, learners must recognize conflicting data and eventually evaluate biases or shortcomings in thinking. Perception of dissonance and "meta-conceptual awareness" (Vosniadou, 1992) are necessary triggering mechanisms for evaluation to occur.

Research on the effects of preexisting beliefs, however, indicate that they are remarkably perseverant and resistant to change (Champagne et al., 1985; Kardash & Scholes, 1995; Perkins & Simmons, 1988). Social theories, such as beliefs about AIDS, capital punishment, or prejudice, are enduring and often difficult to alter, even in the face of examples that counter beliefs (Kardash & Scholes, 1995). Wilson and Brekke (1994) illustrate the unwanted impact of existing social beliefs on actions in the following excerpt:

> Professor Jones is grading papers from a small seminar. When grading Hernandez's paper, undesirable mental processes are triggered by the fact that Jones dislikes Hernandez and knows that Hernandez is a member of a minority group. That is, Jone's dislike and prejudice taints her evaluation, such that the evaluation is more negative than it would otherwise be. Furthermore, assume that Jones would agree that this is unfair and would prefer not to be influenced by her prejudice. This example, then, fits our definition of mental contamination in that Jone's judgment was influenced by unwanted agents (her prejudice). (p. 119).

In this example, the data (the quality of a student's paper) are evaluated in light of existing beliefs that are undesirable and deeply rooted in experience. A disconnect exists between the accuracy of the message sent by the student, and the way it was interpreted and acted upon by the instructor. In order for the biased theory to be weakened and the data to be evaluated accurately, a competing theory must be strengthened as the legitimacy of the original theory is questioned (Holland, Holyoak, Nisbett, & Thargard, 1986).

Yet, novice learners (particularly young learners) do not spontaneously test theories to determine if their thinking is biased (Karmiloff-Smith & Inhelder, 1975; Land & Hannafin, 1997). Rather, they require repeated exposure to counter-examples before gradually recognizing limitations in thinking. But, even when conflicting data about the usefulness of beliefs are repeatedly provided, initial theories may remain largely unchanged. Research examining the evolution of learner beliefs with open learning environments indicates that learners often fail to perceive and interpret data as being inconsistent with existing theories (Land & Hannafin, 1997). Even when learners were confronted with obvious conflicting evidence, they failed to act on the inconsistencies. Instead, they either changed theories temporarily, without acknowledging the previous theory, or discounted the data as an exception rather than attempting to explain it. Paradoxically, when confronted with counter-examples based upon data that is ambiguous (e.g. imprecise visual data), learners often manipulate the data to actually *strengthen* or confirm the existing theory.

Failure to Share Meanings within the System Boundaries: The Situated Learning Paradox

Another assumption underlying the design of OLEs is that learning is optimized when it is situated in an authentic context (Hannafin et al., 1994). Learning is facilitated when opportunities to connect everyday knowledge to new contexts are provided. As learners connect system experiences with prior knowledge, they access existing frameworks that strengthen and elaborate new understanding. It is widely recognized that integrating new knowledge with personal experiences results in more meaningful learning (Mayer, 1984; 1989).

When learners access and use related experiences to construct and annotate meaning, they inherently extend thinking beyond the boundaries delineated by the system. That is, they access experiences that are not represented in, nor are they often able to be represented in, the specific environmental context. This means that meanings accessed from personal experiences will not be communicated to, nor modeled by, the system. As stated previously, meanings are shared as they are represented and communicated via available interface input/output options. In order for meanings to be reciprocally shared, the system's response to a learner's meaning must embody the intended model or message as well as additional information about its veracity. When learner meanings are rooted in prior experiences and cannot be tested within the system boundaries, they are unable to be accommodated or shared by the system. While this is not inevitably problematic, it nonetheless illustrates limited capabilities of the system to adapt to and model learner meanings that are rooted in prior experiences.

To the extent that functionally *related* meanings are accessed from prior knowledge, problems are less significant. Take for instance a hypothetical learning environment where learners can explore the concept of buoyancy and water displacement. The interface might revolve around a virtual swimming pool, where learners can observe how objects of various weights, sizes, and densities float or sink. The leaner may observe, for instance, that a small, highly dense object can sink while a large, less dense object of the same mass does not. Based on this observation, a learner might make the following connection to prior experience: "This sounds like what happens when I curl up into a ball in a pool: I sink. But, when I extend my arms and legs on the surface, I float. But, I have the same weight." This connection represents a functional relatedness to the concept represented: The meaning constructed by the learner contains both the "message" that the system intends to send (i.e., density is a more important factor than weight or size in buoyancy) as well as other *related* meanings based on prior experiences (e.g., "I sink when I curl into a ball vs. when I am extended." These meanings are functionally congruent and, in this one interaction, could be considered shared. While, it still cannot be directly tested in or communicated to the system (unless system can spontaneously change its interface to include options for manipulating the weight of a child in a curled vs. extended position), the result is a richer conceptualization that is now strongly rooted in experience.

Yet, while links to prior knowledge enhance the potential for transfer (Brown, Collins, & Duguid, 1989), they also increase the likelihood that learners will draw upon incomplete and often inaccurate understanding which form the basis of faulty theories. To illustrate using the same buoyancy example, a learner could also conceivably make the following connection to personal experience: "When I wear flotation devices on my arms in a pool, I float. When I don't, I'll sink. I don't sink with the floats because they make me lighter." Incomplete conceptions, such as this, are typical in content areas like science where everyday experiences are at often odds with scientific conceptions (Carey, 1986).

Most learners think that heavier objects fall to the Earth faster and lighter objects float. They also have a collection of personal experiences to support these intuitive theories. The result is a set of robust conceptions that are rooted in personal experience and highly resistant to change. When naive, personal theories are used to inaccurately annotate the meanings communicated by the system, the system is unable to detect or adapt to the conception. Thus, limitations in adaptive capabilities of the system are significant in instances where inaccurate or irrelevant experiences are accessed and used to explain data that is inconsistent with system experiences and *cannot be tested.*

Similarly, Land and Hannafin (1997) noted that learners also referenced prior knowledge and experiences in the *ErgoMotion* roller coaster environment that contradicted, or interfered with, the system's treatment of the concepts of force and motion. One learner referred to the regulating effects of a computer on the speed of the coaster, and the use of brakes and "clamps" for stopping the coaster. She recalled a roller coaster operator telling her that the coaster had brakes and could stop mid-ride. Consequently, she used this information to interpret feedback and drive future actions. She continued to make references to brakes and clamps during remaining use of the system when addressing issues of slowing down and stopping. Her conceptions did not evolve, since they were strongly rooted in experience and could not be tested using the available tools. Consequently, she never confronted evidence to provoke her into questioning these theories. In this case, a belief that the coaster slowed down around the curve (because of brakes or a computer regulating it) interfered with an understanding of force and motion in a context that did not support exploration of the notion.

Such interactions can lead to powerful generalizations since they are linked to prior knowledge but cannot be easily refined using system tools and resources. The effect is further intensified in that prior knowledge and experience are exceptionally robust and persistent. Thus, when learners make connections to prior knowledge, and when they are ill-informed or inaccurate, they cannot be tested within the parameters of the system and thus may endure. While the benefits of building upon meaningful experiences are clear, the challenges of the system to detect and accommodate them remain formidable.

Failure to Share the Rules of Interaction: Incongruent Meta-Level Approaches

OLEs assume that learners are responsible for their own learning and are capable of monitoring the self-directed learning process (Hannafin et al., 1994). The learner is at the center of the environment, both in terms of decisions for using it and ways of making sense from it; instructor or direct information is not available to tell them how to interpret events, nor to monitor the strategic approaches. Consequently, learners invoke their own learning strategies to organize and rearrange the learning process.

Yet, implicit rules for using the system also govern how successfully meanings will be shared. A traditional college classroom, for instance, has an implicit set of rules defined for effective interaction -- i.e., attend class, take and annotate notes, use instructor office hours for help, study for tests and so on. Learners in such environments have some latitude regarding how to study or seek help within the established boundaries (e.g., using study groups; borrowing notes; keeping up with assignments); yet, choosing not to attend class or study for tests, for instance, represent approaches that would not likely lead to success within that given system. An instructor cannot help students develop understanding if they do not use the opportunities that have been afforded them (e.g., attend office hours; use class time for clarification). While strategies and approaches may also depend upon the specific content domain, the implicit rules of interaction must be agreed upon, shared, and understood by both partners at the outset (i.e., teachers and students; students and students; or students and technology).

Similarly, when learning with OLEs, approaches must also be consonant with the rules governing effective use of the environment. For many learners, these strategies and approaches may represent radical departures from standard school-based learning activities. Learners must be able to navigate resources, recognize knowledge gaps and find relevant information, ask driving questions, test hypotheses, and take action to collect and analyze feedback. Incongruent meta-level approaches are significant in that the system is unable to discern whether suitable approaches are being used -- whether a mouse click represents a random vs. reasoned action or whether tools are being used to test theories vs. see what happens.

In order for meaningful learning to occur, both learners and the system must be operating under the same set of assumptions. OLEs require learners to generate hypotheses and to maneuver within the environment, even when knowledge of its rules are incomplete (Holland, et al., 1986). For instance, learners using a thermodynamics microworld might manipulate variables such as surface area, surrounding temperature, and insulation material of an object. They would use data derived from taking action (e.g., testing out a hypothesis that smaller objects wrapped in aluminum will retain heat better) as the basis for addressing a goal and informing future action. Learners use inductive responses (Holland et al., 1986), processing the data that *is* available to begin constructing and refining models.

Problems in effective use of OLEs occur when learners use approaches that are unproductive within that context -- for instance, use of traditional classroom practices within a constructivist environment. In traditional environments, learners collect and learn information prior to using it for deriving or solving problems, often in absence of a meaningful or applied context. The approaches are seldom hypothesis-driven; rather, actions are designed to amass specific information until satisfactory initial insights are acquired. Research on how learners use OLEs indicates that they often rely upon traditional reasoning processes that are unsupported and unsuccessful in the environment (Land & Hannafin, 1997; Wallace & Kupperman, 1997).

Wallace & Kupperman (1997), for instance, found that children often applied a traditional strategy of "finding the answer" to an inquiry- and web-based context. That is, children tended to view the activity as finding an answer to their research question, and "thus reduced the task to finding a single page, the perfect source, on which the answer could be found." (p. 13). The goal of these approaches was to submit search after search until the smallest amount of hits were returned. The following type of interaction reflects this traditional approach:

> "...One pair of students...reacted effusively to small hit lists, singing and calling out 'yes, we got it now...hey you guys, we got it!' when they saw that the number of hits from a search was 18, then reacting with equivalent disappointment when a cursory viewing of the hit list did not reveal an obviously appropriate site: "All these things stink...cause we put in *animals* ... let's delete *animals*." Later, these students produced a hit list with only three pages, and ...exclaimed, "Oh my gosh, we got it!"

In this instance, learners seemed to rely on directed methods for learning in contexts that did not inherently support or promote use of these approaches. When incongruent approaches are used, meanings are communicated according to fundamentally different sets of assumptions. Thus, feedback is less meaningful as learners continue to search for specific answers or information that will not likely be rendered by the system. The result is confusion, disorientation, and frustration (Hill & Hannafin, 1997).

Conclusions

This paper has presented a framework for considering important, but often overlooked, assumptions underlying use of OLEs. Fundamentally, we presume that as learners use OLEs, they perceive relevant information, construct related interpretations, and evaluate discrepancies between their own understanding and the meanings provided by the system. The process by which development of understanding occurs hinges upon a shared, reciprocal and co-constructive sense-making process. Such methods, however, tacitly presume that learners possess the self-regulatory skills needed to make effective judgments, or can be guided to make effective choices through support from the system. Yet, research has indicated that a convergence between initial learner models and desired models do not always transpire (Atkins & Blissett, 1992; Hill & Hannafin, 1997; Land & Hannafin, 1997). The intention of this paper was to emphasize the need for more effective two-way communication of meanings between the system and learner and to indicate where potential misunderstandings can occur.

During recent years, there has been widespread interest in unleashing the capabilities of technology using learner-centered tools and environments. Considerable disagreement exists, however, related to the usefulness of OLEs in supporting problem-solving and learner-centered inquiry. The analysis presented in this paper, in addition to previous research on the topic (Hill & Hannafin, 1997; Land & Hannafin, 1997), have identified problems and issues related to design and implementation of these systems. It is our belief that, in order for technology-based learning systems to evolve, we must begin to isolate what we want to occur, how to design systems to support these goals, and what appears instrumental in influencing effective learning. Indeed, many studies have reported notable benefits of using OLEs to enhance student-centered understanding (Cognition and Technology Group at Vanderbilt, 1992; Harel & Papert, 1991; Scardamalia et al., 1989). Yet, we also believe it is equally important to identify what we *don't* want to occur, what it looks like when the process breaks down, and what appears to be causing the problems to occur. Thus, more complete understanding of the limitations, capabilities, and assumptions of these systems is needed in order to capitalize on the unique potential of OLEs.

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Knowledge, Interest, Recall and Navigation: A Look at Hypertext Processing

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Abstract

An abundance of information in the classroom is conveyed to students through text-based resources. Written discourse is actually the primary information source in secondary classrooms. Research concerning text processing and recall of texts that are traditional in nature (e.g., textbooks, magazine articles, narratives) has highlighted the important influence of a reader's prior knowledge and interest in a given domain on reading performance. However, as the amount of technology used for instructional purposes increases, more students will increasingly be presented with computer-based texts, such as hypertexts. Research examining the roles of variables like knowledge and interest in these nonlinear reading environments has been scarce. The present investigation was undertaken to study how these variables impact recall of information from a hypertext environment. Results indicate that domain knowledge significantly predicts reading recall. The influence of topic knowledge on reading recall however highlighted differential prediction patterns based on the amount of prior topic knowledge the individuals possessed. Hypertext navigation, in conjunction with varying levels of topic knowledge, appeared to impact the amount and type of information recalled.

An abundance of information in the classroom is conveyed to students through text-based resources. Written discourse is actually the primary information source in secondary classrooms (Garner, 1992). Although texts play an important role in the education of students, not all students reap the same benefits from texts. How readers process text may be, in part, attributable to the amount the reader knows about the topic or domain represented in the text, and how motivated or interested the reader is to attend to the information being discussed (Alexander, 1992; Alexander, Kulikowich & Schulze, 1994).

Several different terms representing the construct of knowledge have been presented in the literature on reading (Alexander, Schallert & Hare, 1991). Among these terms are domain knowledge and topic knowledge. By definition, *domain knowledge* is all known information related to a field of study, such as physics, mathematics, or psychology (Alexander, Pate, Kulikowich, Farrell, & Wright, 1989). One consistent finding supported by the literature is that the more domain knowledge that one has, the better one can employ strategies to competently process related text (Alexander, 1992; Alexander & Judy, 1988). *Topic knowledge*, by contrast, covers a much smaller range than domain knowledge. Topic knowledge pertains to knowledge of specific concepts that are encountered in text or connected discourse (Garner & Gillingham, 1991). In general, what a reader knows about a text topic will determine what and how much is recalled from that text (Anderson, 1984; Bransford, 1979).

Interest in a given domain has also been found to influence the amount of time and attention a student will devote to a particular reading exercise (Garner, Gillingham & White, 1989; Hidi & Baird, 1986; Tobias, 1994, 1995). *Individual interest* has been described as interest in a domain or content area (Hidi & Baird, 1988). Alexander (in press) extended this definition to include a deep-seated investment in the pursuit of related knowledge. Research has illustrated that individual interest and text recall have a linear relationship (Schiefele, 1991). That is, as individual interest increases, so does recall.

A second type of interest, *situational interest*, pertains to interest in specific features of text, such as pictures or illustrations (Hidi, 1990). Whereas individual interest is enduring in nature, situational interest is a temporary arousal, tied to transient features of the current situation represented in text (Anderson, Shirey, Wilson & Fielding, 1987; Kintsch, 1980). Recent research has shown that high amounts of situationally induced interest can be detrimental to reading recall (e.g. inclusion of interesting, but unimportant details). Readers may attend to information that is situationally interesting but that is of little importance for understanding the content of the text (Garner, 1992; Lawless & Kulikowich, 1994).

A large amount of research has also examined the interplay between the constructs of knowledge and interest during the process of reading. In a review of knowledge and interest literature, Tobias (1994) emphasized that,

> it seems unrealistic to assume that there is, or should be, little relationship between domain knowledge and interest. People with high interest in anything have probably acquired more knowledge about that subject, because they are likely to spend much more time on activities related to that field than those less positively disposed toward it (p. 44).

Statement of the Problem

The research discussed above has only examined texts considered to be traditional in nature, such as magazine articles, narratives or textbooks. As the amount of technology used for instructional purposes increases, more students will increasingly be presented with computer-based texts, such as hypertexts. Hypertexts differ dramatically from traditional texts in that they afford the reader the opportunity to interact with the text. Rather than prescribing a predetermined order in which information is to be acquired and comprehended, as traditional texts do, hypertexts allow the reader to make decisions about both what information to access, and the sequencing of this information (Landow, 1992). Essentially, a reader must navigate the terrain of a hypertext, thereby arranging his or her own unique text.

Although the opportunity to select the sequencing and type of information is an advantage of hypertexts over traditional texts, it may also place an added burden on readers. When reading a hypertext, students must be able to identify what information is needed to enhance comprehension and where to find that information. Some researchers have suggested that these navigational decisions may present difficulty to readers who do not possess a requisite amount of domain knowledge or topic knowledge, or who are not interested in the content area (i.e., lack individual interest) (Alexander, Kulikowich & Jetton, 1994; Lawless & Kulikowich, 1994).

Hypertexts also appear to have more dimensionality than do traditional texts. That is, hypertexts include many special effects such as digitized movies, sound and visual effects, and graphics. These special features appear to enhance hypertext, making it richer and more complex (Carver, Lehrer, Connell, & Erickson, 1992), and may also increase situational interest. However, this heightened state of situational arousal may cause students to seek out these special features, perhaps at the expense of the instructional content (Lawless & Kulikowich, 1994). As such, it appears that the amount of situational interest an individual has in the computerized environment and its special features may also affect navigation and recall.

The purpose of this investigation was to extend the findings of prior research on knowledge and interest in traditional text processing to more deeply examine the role of these variables in hypertext processing. Specifically, this study examined the relationships among domain knowledge, topic knowledge, individual interest and situational interest within the context of a hypertext environment. Additionally, the relationship among these variables and text recall was examined.

Methodology and Procedures

Participants in this study included 107 undergraduate and graduate students enrolled in the School of Education at a large Northeastern university. This pool of participants was chosen because it was deemed that these participants would have varying knowledge levels of the basic psychology topics that represent the information in the materials used in this study. Further, this sample of individuals comprised a group of students who were considered competent readers (i.e., as determined by academic performance and university enrollment qualifications). Additionally, not one of the participants indicated a reading disability that might interfere with participation in this study.

Materials for this investigation included the following: 1) nine-item open ended assessments of domain knowledge; 2) nine-item assessment of individual interest; 3) nine-item assessment of situational interest; 4) a 150 card hypertext document; 5) a structured recall assessment; and, 6) an unstructured recall assessment. After adjusting for attenuation, reliabilities for knowledge and interest measures all exceeded .75. Interrater agreement concerning the scoring of these assessments were better than 85% in all cases.

Students were first administered, in counterbalanced order, the knowledge and interest assessments. After completing these measures, students were then given a brief overview and tutorial about the hypertext environment including information on how they could access subfields of the text and revisit previous sections of the text as they saw necessary. Students were instructed to study the text and self-selected subfields as carefully as they could for they would be asked a series of questions at the end of their session. These questions were designed to direct students to recall as much of the information from the text as they could.

Results

A series of standard multiple regression analyses was performed to analyze the relationships among knowledge, interest and recall constructs. The use of multiple regression was warranted in this investigation because the examination of the partial correlation coefficients allows for the interpretation of the relationships between independent variables and the corresponding dependent variable while holding all other variables in the analysis constant (Tabachnick & Fidell, 1989). As such, the partial correlation coefficients reveal the unique relationships between constructs by parsing out the variance shared by other variables in the analysis.

Results indicated a significant parital correlation between domain knowledge and individual interest ($r=.28$, $p<.05$), after adjusting for attenuation. However, no significant relationship was identified between domain knowledge and situational interest. When recall measures were used as the dependent variables, domain knowledge was found to be significant predictor of both structured and unstructured recall (partial $r=.285$, $p<.05$, partial $r=.414$, $p<.01$, respectively). However, when topic knowledge was used as the predictor of recall performance, the topic area were participants had more prior knowledge was a significant predictor of structured recall ($t_{96}=2.54$, $p<.01$), whereas the lower knowledge topic area predicted unstructured recall ($t_{96}=2.36$, $p<.05$). Neither interest measure significantly predicted reading recall from the hypertext document.

These results concur, in part, with prior literature on traditional reading environments. That is, domain knowledge has a powerful influence on the amount of information recalled regardless of the media used to present the text. However, the lack of ability to identify a significant relationship between interest and reading recall, in conjunction with the differential pattern of recall associated with topic knowledge areas calls into question whether students use the same strategies when acquiring information from hypertexts as they use with traditional texts. Review of the navigational data of participants through information space afforded by the hypertext highlights that the novel relationships among knowledge, interest and recall constructs in this study might be attributable the various methods of navigation selected by participants. It appears that higher knowledge learners selected and sequenced information more efficiently, thereby facilitating text recall. However, low knowledge readers seemed to have difficulty making associations between informational units from the hypertext environment. Additionally, these readers allocated more time to the special features of the text (e.g., movies, sound effects...) --often times at the expense of more important informational content.

Educational and Scientific Implications

Studying hypertext processing is not a simple undertaking. There are many variables to consider and many types of technological features that can be studied. However, as the information age continues to present learners with environments that house an abundance of materials and resources, it would seem most important to explore the relationships among variables that will facilitate human processing. Navigational strategies appear to be critical to the effective processing of computer-based texts such as hypertexts. As such, researchers need to continue to address the role of navigational strategies and the interaction of these strategies with cognitive and affective variables.

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Narrative Versus Step-by-Step Instructions for Computer Procedures

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Abstract

The purpose of this study was to investigate the effectiveness of narrative versus step-by-step instructions for a computer task. Naive participants were observed as they completed the steps for retrieving, replying, spell checking, and sending email using software on a mainframe computer. There was no performance time difference between the two groups, but the step-by-step treatment made fewer errors during the more complex tasks.

One problem often slighted in the software development process is the development of appropriate documentation for the user. This observation is supported by the growing number of after-market software books and the growing need for software technical support. Although there are many examples of excellent software manuals, there are also numerous examples of manuals that offer little more than a programmer's description of how the software works. An analysis by Kaplan (1989) revealed five types of software documentation: reference manual, tutorial manual, user (or combination) manual, quick reference card, and on-line help. She believed that for novices, ". . . the tutorial is the most essential piece of documentation" (p.32). One problem with tutorials is the writer's potential for underestimating the intelligence of the user and sinking to the "Dick and Jane" level (Deterline, 1988).

McGehee (1984) defined tutorials as "a cookbook, hand-holding, step-by-step method of teaching the concepts and techniques of using a program" (p.57). It is interesting to note that McGehee's definition uses the term step-by-step, which suggests a non-narrative approach. Tutorials are recommended by McGehee if the manual is the user's first introduction to a program, if the program is complex, and if the user is a computer novice. The major problem identified with writing tutorials is trying to match the user's knowledge, a problem that depends on the particular software and the intended audience. Deterline (1988) issued a plea for inclusion of user needs when documentation is written, because much software documentation is written by subject-matter experts (SME), often the computer programmers and it is very difficult for non-experts to comprehend.

If the documentation manuals are the user's first contact with the software, how should the information be presented? Brockmann (1990) discussed the limitations of tutorials in general, which he believes may constrain users to a set of minimum expectations. Tutorial material is "usually organised around user tasks or around a hierarchy of user needs" (p. 74) In contrast, Thurston (1986) states that general purpose computer programs (e.g. programming languages) are better served with narrative form tutorials, while narrowly defined programs (e.g. accounting packages) are best dealt with using step-by-step tutorials. Webb (1989) also recommended step-by-step tutorials for procedures and narrative form for overviews or introductions. "Cookbook" tutorials which consist of simple action sentences (e.g. Turn on computer. Click on icon for program. Select word processing) differ in form from numbered steps which move users sequentially through a procedure tutorial (e.g., 1. Turn on computer. 2. Locate the program's icon. 3. Double click on the icon. 4. When the program starts, find the box for word processing and click on it). Tutorials, regardless of form should begin with a general overview and include as many illustrations as possible. However, Kaplan (1989) suggests that narrative style instruction often hides important messages in a mass of text. Although the use of numbered steps makes logical sense for complex tasks, a review of the instructional design literature failed to identify any research comparing narrative versus step-by-step approaches to teaching procedures.

The purpose of this study was to investigate the effectiveness a narrative versus step-by-step presentation of a procedure for naive computer users. It was predicted that the step-by-step approach would be more time efficient, since a narrowly focused application (email) was used in the study. It was also predicted that participants receiving the step treatment would make fewer overall errors and fewer errors of each type. We were also interested in knowing how the two treatments influenced participants' attitudes toward the instructional materials.

Method

Participants

The participants in this study were 31 undergraduate education students enrolled in a computer literacy course at the University of Memphis during the Summer, 1996 semester. The participants generally had little computer experience and many suffered from "computerphobia." None of the participants had any prior knowledge of email. Participants were randomly assigned to one of the two treatment groups.

Materials

The treatment material consisted of a three part instructional unit providing information on how to log onto the University EMAIL system, read and compose email, spell check, reply to, and send messages. The instructions encouraged students to proceed at their own pace.

Lesson Description

A unit of instruction was on how to use the University's VAX EMAIL server, compose, read, spell check, reply to, and send EMAIL messages using the VAX software. The first treatment group was the narrative treatment (n=15). This treatment group read text presented in a traditional narrative format with each paragraph including from three to seven steps. The following is a sample of the narrative treatment.

> Turn on your computer. After the computer has finished its start-up process, you will see the "Finder" screen. Use the mouse to move the arrow to the Apple icon (picture) in the top left corner of the screen. With the arrow pointing at the Apple icon, press the mouse button and hold it down.

The second treatment group (n=16), step-by-step, read instructions that were clearly enumerated and separated from each step. The following is a sample of the step-by-step treatment.

1. Turn on your computer.
2. After the computer has finished its start-up process, you will see the "Finder" screen.
3. Use the mouse to move the arrow to the Apple icon (picture) in the top left corner of the screen.
4. With the arrow pointing at the Apple icon, press the mouse button and hold it down.

The two treatments contained the same information but varied in the way it was displayed on the page. The only difference was the numbering of the steps in the second treatment.

Instruments

After completion of their respective treatments, participants were given a survey designed to assess their attitudes toward the instruction. The attitude survey consisted of six core items that asked participants to rate the lesson, computer learning, the VAX system, the usefulness of email, this lesson, the sufficiency of items, and future email use using a five point Likert scale (1=strongly disagree, 5=strongly agree). The second instrument was an observation form used by the experimenter during the treatment. The form listed each step of the process with places to indicate if the step was performed correctly and in sequence, performed incorrectly, performed correctly out of sequence or skipped. There was also a place for noting the starting and ending times and a section for noting participant behaviors (see Figure 1).

Figure 1. Performance Rating Form

Step Outcome	Correct	Wrong Command Key	Wrong Entry Typed	Wrong sequence but worked	Wrong Sequence error	Other
Starts up computer.						
Logs on successfully.						
Changes password if necessary.						
Reaches mail prompt.						
Creates new message.						
Enters message.						
Sends message.						
Logs on successfully.						
Reaches mail prompt.						
Reads new message.						
Replies to message.						
Spell checks message.						
Sends message.						

Procedure

Participants were scheduled to complete the instruction in a one-on-one setting with the experimenter. Each was seated at a color Macintosh computer (LCII or LCIII) and given the printed instructions. The starting and ending times were noted for each participant. The experimenter observed each subject complete the tasks. The sequence of steps completed and the type of errors made were recorded by the experimenter using the following instrument. Each time a participant attempted a step, the participant's action was evaluated and recorded on the checklist.

Results and Discussion

The first analysis was a comparison of completion times and overall errors for each of the treatments with T-tests and using SPSS statistical software. No significant differences were found for time on task (times ranged from 19 to 23 minutes), or overall errors by treatment (overall errors ranged from 0 to 4).

The errors in the 13 steps in the procedure were summed into four groups: Steps 1-4 (initial logon); Steps 5-7 (composing and sending message); Steps 8-10 (logon and reading message); and Steps 11-13 (replying, spell checking and sending message). Only the final group of steps varied significantly by treatment when compared using MANOVA, with the step procedure group making fewer errors (F=5.0024).

Table 1. Errors on Task

Variable	Treatment #1 (Narrative)		Treatment #2 (Step)		F. Prob.
	Mean	*S. D.*	*Mean*	*S.D.*	*p<.05*
Error Steps 1-4	.200	.414	.563	.814	.1329
Error Steps 5-7	.600	.632	.313	.479	.1626
Error Steps 8-10	.067	.258	.000	.000	.3097
Error Steps 11-13	.533	.640	.125	.342	.0332

When type of errors by treatment were compared with MANOVA, only the Wrong Command Key errors differed, with the step procedure treatment group making significantly fewer errors (F=7.1382).

Table 2. Errors by Treatment

Variable	**Treatment #1 (Narrative)**		**Treatment #2 (Step)**		**F. Prob.**
	Mean	*S.D.*	*Mean*	*S.D.*	*$p<.05$*
Wrong Command Key	.733	.704	.188	.403	.0122
Wrong Entry Typed	.400	.632	.750	1.065	.2790
Wrong Sequence but Worked	.133	.352	.063	.250	.5212
Wrong Sequence Error	.200	.414	.000	.000	.0629

MANOVA comparisons found no other significant differences between groups for Looks at Instructions, Asks for Help, or Shows Frustration. The attitude survey questions also revealed no significant differences between treatments, although both treatment groups recorded positive overall attitudes toward the instruction.

The lack of significant differences in times for the treatment groups may have resulted from a motivated participant group. All participants were required to learn to use email in their ongoing literacy course which may have resulted in a greater degree of learner engagement than might have otherwise occurred. Thus there was no support for the first hypothesis (the step approach will be more time efficient). This finding is in agreement with a study by Morrison, Ross, Case and Gopalakrishnan (1995) which found that purposeful engagement raised scores.

Similarly, there were no significant differences in overall errors by treatment in this study. This lack of difference may be due to the relative simplicity of the procedure, with few opportunities for errors. However, there were significant differences in performance on the most difficult part of the procedure (replying to a message, spell checking and sending the reply). The step-by-step group made fewer keystroke errors. This finding suggests that step-by-step procedures may produce fewer errors when the procedure is more complex. Participants using the narrative approach found this group of steps very difficult and often showed frustration while attempting to complete the tasks. The step-by-step group appeared to have gained enough confidence in their ability that they were not as intimidated by this portion of the lesson.

Significant differences were also found for Wrong Command Sequence errors. A Wrong Command Sequence error occurs when a participant presses the wrong key and is not successful at completion of the step. This result appeared to be due to a loss of concentration by participants receiving the narrative treatment. These participants often lost their place in the procedure because they lacked the number cues provided to the step-by-step participants. This finding is consistent with Thurston's (1986) recommendation that step-by-step procedures are more appropriate for narrowly defined applications such as email.

The lack of differences in attitudes by treatment may be explained by the participants' need to acquire the skill taught by the lesson. Some negative behaviors were observed during the treatments (mostly impatience over having to read the instructions), but the majority of the participants were positive (and often enthusiastic) about their new skill. Another factor that may have influenced performance and attitudes was the individualized testing situation. This approach was in direct contrast to the 20:1 student-instructor ratio in the computer literacy class. This one-on-one environment may have increased their confidence. Also, the treatment instructions were considerably more detailed than those provided in the textbook.

Most of the students (n=28) were forced to seek help from the experimenter at least once because of confusion over the procedure, especially when asked to choose a new password (problems included new password already in use and illegal password selected). Almost half (n=13) showed signs of frustration, especially when trying to press the CONTROL-Z key combination, which is a unique keystroke on a Macintosh. No participants attempted to explore the menus or other options and only one participant tried to send any additional messages.

It appeared from the observations that the major determining factor of success was the participant's motivation, not the format of the written procedure. Participants who experienced difficulty appeared to skip portions of the printed lesson and skimmed longer explanations which resulted in less understanding and more errors. Participants with higher motivation completed the tasks with few mistakes and displayed interest in the underlying structure of email. Those with lower motivation often ignored instructions (especially concerning spell checking) and showed little overall interest.

The differences in Control Key sequence errors indicated that the step procedure produced fewer errors. One possible explanation is that the more complex the task and the more critical the order of the steps, the more advantageous are the step procedures.

Overall, the results were less conclusive than predicted, but significant differences in two of the variables examined (Steps 11-13 and Wrong Command Sequence) indicates that there are measurable differences between the two methods of instruction.

Recommendations

The study indicated that differences in effectiveness of step-by-step procedures may be less than generally believed. The results of the study suggests additional research with complex procedures should be used to determine if complexity of task plays a part in differentiating methods of instruction. Future studies should include a variety of tasks that are simple and complex, short and long, and familiar and unfamiliar to the participant.

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Proximal Instruction Strategies and Assessment Tools for Managing Performance-Based Learning

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Abstract

Educators have not yet clearly described effective methods for implementing and managing performance-based learning experiences that incorporate electronic technology. While we have recognized the benefits of constructivist approaches to learning, the literature says little about the role of the teacher within computerized learning contexts. This paper reports on two research studies. The first research study investigates teachers monitoring strategies during computer-assisted composition instruction. The findings reveal four principles underlying a strategic, proximal instructional process. The principles are collaborative assessment, guided practice, instructional branching, and learner self-monitoring skills' development. The computer is described as a cognitive tool supporting and facilitating teachers' active involvement in students' actual writing process which represents a change in process writing pedagogy found in non-computerized settings focused on analysis of students' writing products, albeit drafts. The second study reports on a related issue concerning the design of electronic performance-based assessment systems. The findings are a set of guidelines instructional designers and educators can use in planning for the use of electronic assessment systems for educational purposes. Both studies point to the need for technological solutions to provide efficient, valid, and reliable information available to teachers and learners to enhance the types of instructional processes that accompany active, engaged learning experiences.

Background and Theoretical Perspective

Educational reform measures call for authentic learning contexts. Technology has the potential to facilitate and support authentic, performance-based learning experiences through its capacity to interactively engage learners. Educators, however, have not yet clearly described effective instructional methods for implementing and managing performance-based learning experiences that incorporate electronic technology. While we have recognized the benefits of constructivist approaches to learning, the literature says little about role of the teacher within computerized learning contexts. In a seminal work, Collis (et.al., 1996) reported findings from three international research studies focused on computers and learning across multiple contexts. In the analysis of the data, the teacher was identified as the critical influence in enhancing students' learning regardless of many variables at the classroom, hardware, and software levels.

This paper reports on two studies addressing issues related to performance-based learning and uses of technology to support it. The first study describes findings from a grounded-theory research study focused on writing teachers' monitoring activities in a computerized learning environment. The findings describe a set of instructional strategies that facilitate proximal instruction and its implications for authentic, performance-based learning experiences. The second study describes the development of guidelines for using technology to help manage the types of data generated from performance-based learning experiences. Standardized assessment methods are inadequate for tracking and reporting educational progress found in performance-based approached to education. That is not to say all standardized testing is out, and alternative assessment is in. Rather, constructivist approaches to learning call for the use of alternative assessment measures 1) to develop the learner's cognitive strategies for self-monitoring of progress, 2) to foster the learner's ability for higher-order thinking skills, 3) to measure progress against the learner's own development, not the norm, and 4) to provide more accurate evidence of a learner's abilities than traditional tests (Boyer, 1995; Cole, Struyk, Kinder, Sheehan, and Kish, 1997; Wiggins, 1993).

The educational reform movement has been strongly felt across educational contexts. The general public wants students to be prepared to meet the challenges inherent in our complex and fast-paced culture, challenges that are often driven by technology. Learning content and context is coming under careful examination to evaluate the relevancy and applicability for preparing children to live in a high-tech society. Our technological society requires higher-order thinking skills such as interpreting, evaluating, synthesizing, and communicating new knowledge; problem solving; collaborative teamwork; goal setting; and decision making. Students need to learn how to monitor their own thinking processes and how to use technological systems to manage and convey information. The research discussed in this paper provides a rationale for using proximal instruction strategies and technological management tools to support learner-centered principles in education. Learner-centered principles, which underlie constructivist approaches to education (McCombs, et al, 1993), claim that learning which is closest to the self is the most powerful. This paper provides insight into monitoring strategies and technology guidelines that can assist teachers and student with individualizing instruction and assessment as well as fostering student accountability for learning.

Investigating Teachers' Monitoring Strategies

The literature reflects a historical problem with technology implementation efforts. The problem is that curriculum-making power, historically vested in the teacher, becomes vested in the technology system and overrides the teacher's decision-making abilities, which represents a deskilling effect (Streibel, 1993). Yet the teacher is still responsible for implementation choices at this point in time. Knupfer (1993) argues that "the success of any such implementation effort will depend largely on the teachers who determine the daily school activities" (p. 164). Knupfer criticizes research agendas that focus exclusively on the dynamics between the learner and technology. She also points out that research about the teacher's role in implementation has received little attention, despite "an overwhelming body of evidence [that] points to the centrality of teachers in the process of educational innovations" (p. 165).

In regard to the implementation of computer-assisted composition instruction, Selfe (1990) writes that the computer-assisted composition instruction movement has been accompanied by a pioneering spirit that "remains atheoretical, untested, unexamined, and less than systematic" (p. 191). Likewise Reinking and Bridwell-Bowles (1991) claim that "no comprehensive computer-based writing curricula have been developed" (p. 314). The research conducted in the field of computer-assisted college composition instruction reflects the broader approach of technology implementation efforts--a focus on learner-technology dynamics at the exclusion of learner-teacher dynamics. Curtis and Klem (1992) echo the concern for a lack of research about teachers in computerized teaching environments:

> Our own readings have found a corresponding absence of teachers and actual teaching from the bulk of computer research, even from examination of the computer's relationship to teaching methodology; the focus, rather, seems inevitably to shift to the presence of the machines. We fear that this shift denotes a somewhat odd substitution of computer for teacher as locus of influence, instruction and motivation among student writers (p. 157).

The problem with the shift is that computer systems and programs are not a substitute for social interaction processes relevant to the teaching of writing. During the writing process the writer acts "as a creator of meaning" (Berlin, 1994, p. 19). In addition, the substance of the writing embodies differences in human experiences, values, purposes and goals. Berlin points out the pedagogical value put on fostering writers' individuality.

This section of this paper reports on a research study conducted by McNabb (1996) that had two primary purposes. First, its purpose was to describe the monitoring activities engaged in by composition teachers who are involved in implementing computer-assisted composition instruction. The second purpose was to articulate the pedagogical principles underlying the monitoring activities of teachers in the context of computer-assisted composition instruction. The researched focused on the monitoring activities of teachers during computer-assisted composition instruction with the assumption that teachers' monitoring strategies were key indicators of what facilitates writing skill development in student writers during computer-assisted writing activities. This premise arose from a body of literature about the cognitive writing process grounded in the seminal research conducted by Hayes and Flower (1980). Hayes and Flower identified a "monitor" as a component of the cognitive writing process; the monitor was believed to facilitate recursion between the planning, production, and revision stages of the process writing model. While those in the field of English composition have conducted a vast amount of research regarding other subcomponents of the cognitive writing process model developed by Hayes and Flower, the monitoring component of their model has gone largely unresearched. Nonetheless, others have categorized monitoring as metacognition inherent in the writing process (Flavell, 1987; Perkins, Simmons, & Tishman, 1990; Scardamalia, Bereiter, & Steinbach, 1984). Thus, the research represents an original approach to studying the cognitive writing process by focusing on the monitoring activities that teachers engage in with student writers during computer-assisted instruction.

Two central questions guided the investigation: 1) What are the characteristics of composition teachers' monitoring activities in a computer-networked learning environment?, and 2) What is the nature of the association between the teachers' monitoring activities and students' computer-assisted writing activities?

Research Method

The researcher employed grounded-theory methodology to gather data about the monitoring activities of teachers during computer-assisted composition instruction. A grounded-theory approach was used to inductively construct a theoretical framework for interpreting the social phenomena understudy (Corbin & Strauss, 1990; Glaser 1978, 1992; Glaser & Strauss, 1967; Strauss, 1987; Strauss & Corbin, 1990, 1994). Research derived from grounded-theory methodology typically provides insight into "patterns of action and interactions between and among various types of social units (i.e., actors)" (Strauss & Corbin, 1994, pg. 278). The patterns of action and interaction between teacher and student and the underlying conceptual processes were the focal point of this research project; hence, grounded-theory methodology suited the research project well. The primary purpose of the study was to describe and explain teachers' monitoring practices during computer-assisted composition instruction. The initial working definition of monitoring was any interaction between teacher and student(s) during the computer-assisted instructional sessions.

The research was conducted through the English Department at a mid-sized public university representative of mainstream American institutions of higher education. The English Department advocated process-writing pedagogy in teaching the traditional freshman composition sequence. The English Department also had a 10-year history of implementing computer-assisted instruction (CAI) in the composition course. The year this study was conducted, the university had implemented CAI into 100% of the freshman two-semester composition sequence. The study occurred in the last six weeks of the second semester of the two-course sequence. Nine teachers and their 180 students were selected for the study. The teachers played three roles in the study. First, the teachers were subjects of the researcher's observation and inquiry. Second, they took on the role of participant observer. Third, they served as key informants for collecting, analyzing, and reporting data. In order to answer the research questions, the researcher designed and used a screening questionnaire to select the participant teachers and designed the initial procedures and instruments for data collection based on perspectives from the technical literature in instructional technology, educational psychology, and composition pedagogy. Teachers selected for participation in the study held important similarities in their teaching practices and beliefs about the writing process and instructional uses of the computer, according to the screening questionnaire. Thus, the data represents the monitoring practices of a relatively homogeneous group, which allowed for the rich variation in monitoring strategies used in computer-assisted process writing to emerge. After selecting the participant teachers, one of each teacher's two assigned course sections was randomly selected for the study. The level of writing skill among the student groups was assumed to be similar, since students were pre-tested by the university and placed into writing classes according to similar writing skills.

In order to answer the stated research questions and to add strength to the design of the study, triangulation of data collection occurred in a naturalistic setting. Data sources included observation of 45 CAI sessions and in-depth beginning and exit interviews with participant teachers. The teachers tape-recorded their naturally occurring dialogue with students during the CAI sessions. They captured students' beginning and ending electronic files on the computer network and transferred the files on to computer disks for archiving. They wrote and submitted key incident reports about their monitoring strategies according to the guidelines that emerged during the study (see Appendix). The key incident reports emerged as a significant data source which illuminated the observations and teacher interviews that the researcher conducted. A student exit survey was also administered. The survey illuminated important characteristics of the teachers' monitoring activities.

Research Findings and Discussion

Analysis of the key incident reports showed an emphasis on tasks requiring students to reflect, evaluate, and appropriate their task performance decisions during computer-assisted writing. Three categories of assignments emerged in the data. These were categorized as organizational assignments, revision assignments, and MLA citation and documentation assignments. The teachers appeared to use these types of assignments as benchmarks for assessing students' developmental level of writing skills. Teachers' monitoring strategies associated with the assignments varied from student to student. Multiple assignments were accessible on the network server for students to complete at their own pace. Students routinely engaged in the computer-integrated writing activities independently while the teacher monitored their progress. Teachers used a complex arrangement of monitoring strategies to identify students' achievement levels in order to facilitate the students' incremental, or nearby, skill development along a continuum toward instructional goals. Teachers used monitoring strategies to remain in close proximity to the students' developmental skill needs and provided context-appropriate strategic interventions documented in the key incident reports.

Seventeen of the 43 key incident reports describe the use of open-ended monitoring strategies. In these 17 reports, the teachers reported that the student had solved his or her own problem during and/or following monitoring. In-depth analysis of these key incident reports, including the student's before-and-after-instruction computer files and transcribed dialogue, indicated that the monitoring experiences had resulted in the students' autonomous, incremental skill development. Teachers provided written analysis describing the consequences of their interactions with students, drawing from evidence in the tape-recorded dialogue and observed changes in the students' computer-assisted writing performance. A pattern of *descriptive monitoring* strategies emerged in the key incident reports where teachers reported student progress. Descriptive monitoring strategies are characterized by a variety of open-ended cues and interaction tactics used by teachers to elicit reflective, evaluative, and appropriative responses from students.

Another nine key incident reports documented teachers use of directive strategies to help students move forward in their computer-assisted writing tasks. These reports documented that the students had mimicked the teachers' proposed problem solutions. These imitative responses also constituted incremental skill development in the students' computer-assisted writing skills. However, the skill development appeared to be associated with a lower level of learner autonomy. These key incidents involved teachers' *prescriptive monitoring*. Prescriptive monitoring strategies are characterized by a variety of closed-ended comments and explicit demonstrations the teachers used to pose problem solutions, and which typically elicited imitative responses from students.

In six additional key incident reports, the teachers used either descriptive or prescriptive monitoring strategies that did not result in students exhibiting incremental skill development according to analysis of the students' before and after instruction writing. These six reports showed that teachers ineffectively assessed or misdiagnosed the student's monitoring needs in relation to the assignment tasks and their respective skill level. Consequentially, the monitoring strategies teachers used in these cases were ineffective for the given learning context. The observation notes, unstructured interviews, key incident reports, and student exit survey all indicated that a primary function of teachers' monitoring was to engage students in self-reflection, self-evaluation, and self-appropriation activities aimed at facilitating their ability to solve their own computer-assisted writing problems. The monitoring strategies teachers used represent a complex social-psychological process characterized by diagnostic monitoring strategies, followed by subsequent instructional branching by teachers. Teachers employed a complex schema of monitoring strategies based on individual student response(s) to their monitoring. A dominant characteristic of the instructional process that facilitated the students' incremental skill development was the social interaction between teacher and student. The student survey indicated that, in addition to the social value of personal interactions, observing interactions between teacher and peer(s) often served as a learning experience for students. Figure 1 shows the flow of interactions observed among the participants of the study. During the interactions, the teacher served in three primary roles that characterized the instructional process: co-evaluator, coach, and facilitator.

Teacher as Co-Evaluator

The teacher as co-evaluator put emphasis on the developmental context surrounding students' writing performance. A student's individual stage of development as a writer emerged as a critical factor regulating the teachers' monitoring activities. Stage of development refers to a given student's level of skill in relationship to the computer-assisted writing goal at any given moment during the observed sessions. Teachers reportedly selected their monitoring strategies based on student's developmental skill needs. The teacher acted as co-evaluator during collaborative assessment activities. Peers also played an evaluation role. This was indicated in the student exit survey, key incident reports, and observed activities. At times, teachers' assigned peer evaluation tasks such as online peer critique exercises. At other times peer evaluation behaviors arose spontaneously through student initiated interactions. In order to evaluate students' progress during CAI, teachers employed *collaborative assessment strategies*.

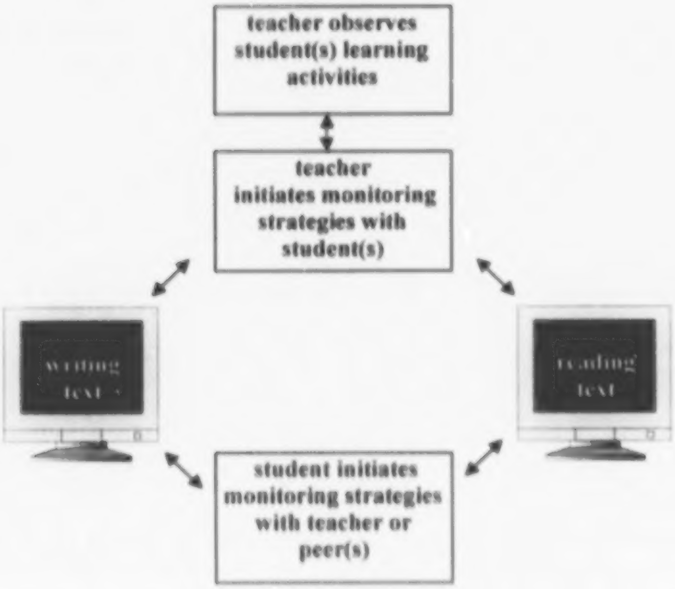

teacher observes student(s) learning activities
teacher initiates monitoring strategies with student(s)
writing text
reading text
student initiates monitoring strategies with teacher or peer(s)

Figure 1. Shows a common interaction pattern among teacher, students, and peers observed within the computerized learning environment.

The reciprocal social interactions between the teacher and his or her students during computer-assisted writing activities fostered contextual learning experiences. The teacher used collaborative assessment strategies to engage the student in overtly identifying his or her instructional needs. Through the collaborative assessment experience, the teacher and student became aware of the student's achievement and/or knowledge level as it related to curricular goals and objectives. The heightened awareness assisted the teacher in making instructional decisions and appeared to prepared the student for learning. The following monitoring strategies characterize collaborative assessment:

- *Roaming*, or circulating around the computer lab arena while students work on their assignments, occurred in conjunction with observing to check students' progress toward learning objectives and curricular goals.

- *Observing* appeared vital to the assessment process, i.e. global observing of the whole group and local individual student and computer screen-specific observing which allowed the teacher to identify each student's progress or lack of progress.

- *Assessment prompts* were used by the teacher to engage students in dialogue and included open-ended questions, leading questions, and exploratory and probing cues, which were designed to facilitate dialogue leading to identifying the student's achievement and/or knowledge level and to clarify any problem(s) hindering student progress.

Teacher as Coach

Another teacher role was that of "coach"; teachers used this word to describe their primary instructional role. Teachers reportedly used coaching strategies to provide students' with *guided practice* experiences. The coaching process found in the data involved the student in performance of a given task while receiving strategic prompts from the teacher. The primary distinction between coaching and evaluating is that coaching refers to instructional strategies while evaluating refers to assessment strategies. In actual practice, the two worked hand-in-hand.

The teacher determined the strategies for guiding student practice of a given writing task based on the insights generated during the collaborative assessment process. The teachers used a variety of context-appropriate descriptive and prescriptive monitoring strategies to help guide the students' active learning. Through reciprocal interactions focused on a particular problem hindering the student's independent performance of a given task, the teacher provided guidance that supported the student's incremental skill development. The strategies listed below illustrate the primary descriptive and prescriptive monitoring strategies found in the data, but are not meant to be a comprehensive listing. *Descriptive monitoring strategies* are characterized by a variety of open-ended cues and interaction tactics used by the teachers to elicit reflective, evaluative, and appropriative responses from their students. For example:

- *Exploring* or *probing* a variety of alternative methods and/or perspectives;
- *Mirroring* back to the student his or her own thinking process through verbal reiteration;
- *Negotiating* the method for accomplishing a task or the meaning of a text;
- *Prompting* the student to think in-depth about his or her ideas and the language used to express those ideas within an argumentative context; and
- *Simulating* contexts for learning that resemble situations calling for autonomous skill performance, i.e., counter-argumentation techniques or Socratic dialogue.

Prescriptive monitoring strategies are characterized by a variety of closed-ended comments and explicit demonstrations the teachers used to pose problem-solutions, and which typically elicit imitative responses from students. For example:

- *Explaining* or *elaborating* on the purposes, beliefs, procedures, rules, and/or conceptual substance of a computer-assisted writing task;
- *Goal-setting* to make explicit the characteristics of a task and/or the subcomponent of the task that acts as a benchmark of achievement;
- *Modeling or demonstrating* for the student how a given task may be accomplished; and
- *Suggesting* specific solutions to a given writing and/or computer usage problem.

Teacher as Facilitator

A third teacher role that emerged in the data was that of facilitator. Although the teachers' monitoring exhibited many characteristics of constructivist approaches to learning, with an ultimate goal of writer autonomy, teachers did use directive strategies to manage the instruction process on an individual learner level and a group level. In their interviews, teachers described the diversity of spontaneous social behaviors among students. The diverse social interactions documented in the researcher observation notes also indicated variation among students. The teachers, through their global comments and more individualized monitoring strategies, set pacing goals that students' continuously modified through reciprocal social interactions. This phenomenon indicated a range of individualized writing processes among the 180 student participants in the study. Differences in writing processes of individual student writers were mentioned in the technical literature as well (Berlin, 1994; Hayes & Flower, 1980; Tierney & Shanahan, 1991). While the characteristics of students' individualized writing processes was not the focus of this research, there was evidence that teachers adjusted their monitoring strategies to a range of student needs for facilitating learning throughout an instructional session. The teacher role of facilitator is characterized by using branching strategies to promote optimal timing and sequencing of tasks and interactions during CAI.

The teachers employed instructional branching strategies to determine the optimal sequencing and timing of the monitoring cues provided to students during computer-assisted instruction. Optimal sequencing of a student's assigned tasks was determined through the assessment-in-instruction monitoring pattern unique to each teacher-student relationship. The teacher's optimal timing for using descriptive and prescriptive monitoring cues, in relationship to assigned tasks, was determined through collaborative assessment strategies. Instructional branching strategies included the following:

- *Effective timing of appropriate monitoring cues* at the student's critical point-of-need in order to facilitate incremental skill development

- *Management of multiple interventions* in a student's task performance activities through individualized, small group, and/or global interactions that may be teacher or student initiated

- *Wait time* following a strategic instructional intervention coupled with observing the student's consequential performance level

- *Open-ended assignment agenda* supported by a computer networked archive of assignments available that facilitated individualizing the instructional process based on the student's progress along a continuum toward curricular goals and objectives

The data showed a relationship between the time a teacher spent engaging a student in various types of monitoring interventions and the student's need for guidance while performing a given assignment. Students with less autonomy associated with a given learning goal typically received more prescriptive monitoring. Those closer to achieving the goal received more descriptive monitoring. When students responded well to prescriptive monitoring, teachers often followed up with descriptive prompts. The decision to change strategies appeared to stem from ongoing collaborative assessment. Figure 2 depicts the instructional process the researcher calls proximal instruction. In addition, the key incident reports and associated transcribed teacher-student dialogues illustrated how a student's inability to respond favorably to descriptive monitoring strategies often caused the teacher's to branch to prescriptive monitoring strategies. This phenomenon indicates the ecletic nature of teachers' monitoring strategies during computer-assisted writing instruction. Ultimately, the teachers' instructional goal was the development of students' autonomous writing skills, skills characterized by self-monitoring.

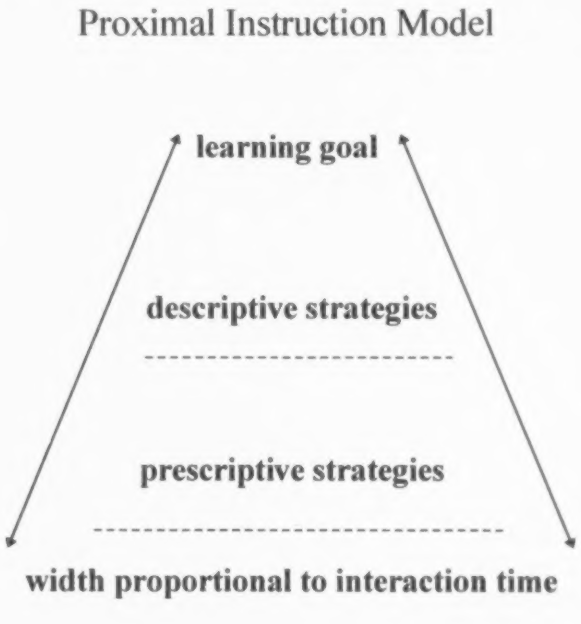

Proximal Instruction Model
learning goal
descriptive strategies
prescriptive strategies
width proportional to interaction time

Figure 2. The model illustrates the relationship between the time teachers spent engaging a given student in various strategic interventions and the student's apparent need for guidance while performing a given task in pursuit of a learning goal. The arrows represent the ongoing collaborative assessment-in-instruction and the branching strategies used by the participants.

The students engaged in collaborative assessment and self-monitoring experiences guided by the teachers. During these experiences, the teacher typically challenged the student to reflect on, evaluate, and appropriate solution(s) for a specific problem that was hindering the student's independent task performance. As a result, the student increasingly managed his or her own computer-assisted writing process as much as he or she was able, before soliciting intervention from the teacher or a peer.

This research identified the following three types of self-monitoring skills associated with computer-assisted writing instruction:

- *Self-reflection* involved prompting one's self to explore and articulate one's ideas through writing.
- *Self-evaluation* involved prompting one's self to read and analyze one's written ideas.
- *Self-appropriation* involved prompting one's self to make decisions (including revisions) about the relevance and applicability of one's ideas in a given rhetorical context.

During monitoring, teachers challenged their students to acquire reflective, evaluative, and appropriative skills for writing. The key incident reports and student exit survey results indicated that these three skills were the primary focus of the computer-assisted composition instruction under study. The researcher interpreted the teachers' focus on helping their students locate, understand, and solve their task performance problems as a process of facilitating their metacognitive skills and/or knowledge related to writing ability. Metacognitive knowledge "consists primarily of knowledge or beliefs about what factors or variables [persons, tasks, and strategies] act and interact in what ways to affect the course and outcome of cognitive enterprises" (Flavell, 1979, p. 907). In the substantive area, the teachers' monitoring activities focused on providing students with metacognitive strategy knowledge through interactive, strategic monitoring experiences.

Teachers' monitoring activities resembled characteristics of Vygotsky's zone of proximal development found in the literature (Bruner, 1986; Dixon-Krauss, 1996; Miller, 1993; Vygotsky, 1978). Therefore, Vygotsky's work was selected as a valid developmental theory that informed the development of the principles emerging from this research project. According to Bruner:

> In contrast with learning theories and developmental theories which merely *describe* processes, an instructional theory should *prescribe* the optimal arrangements of conditions which will facilitate meaningful school learning. An instructional theory should be developed alongside learning and development theories, and its principles should be congruent with psychological theories. (Snelbecker, 1985, p. 419)

Additional characteristics from learning theories that appeared to be highly relevant to the teachers' monitoring process were found in literature by Feuerstein and Feuerstein (1991), i.e., the concept of reciprocity between teacher and student, and by Dewey (1939), i.e., the principle of educative continuity. Bruner's guidelines for constructing instruction theory were used to develop descriptions of the four principles of the proximal instruction process: collaborative assessment, guided practice, instructional branching, and self-monitoring skills' development. These principles served to integrate the conceptual categories generated from the analysis of the data collected for this study and provide a basis for further research in this area (Snelbecker, 1985; Miller, 1993).

Teachers monitoring strategies appeared effective in identifying the point at which students were unable to perform independently. The efficacy of teachers' monitoring practices is supported by the following statement from the technical literature: "Considering choices and articulating rationales for particular composing decisions fosters metacognitive awareness--a hallmark of an expert writer" according to David, Gordon, and Pollard (1995, p. 530). Throughout the data were indicators that teachers used descriptive monitoring strategies to foster students' abilities to make their own writing choices, i.e. self-evaluation and self-appropriation. When students were not able to independently make reasonable writing choices, teachers used monitoring strategies to assist and/or guide students' reflection about their decision-making process. David, Gordon, and Pollard (1995) point out that "conscious control of one's own writing processes [is] a feature of expert writers" (p. 530). The students involved in this research were novice writers. Participant teachers appeared to lead students through monitoring experiences conducive to development of their own self-monitoring strategy knowledge and skills.

Characteristic of teacher monitoring was the goal of fostering students' autonomous expression. McCombs and Whisler (1989) explain autonomous learning from a developmental perspective. "Psychologists and educators have increasingly recognized that learning is an internally mediated, active, generative, and constructive process of attending, processing, and transforming information into both relatively stable and dynamic knowledge structures" (p. 277). These researchers point out, however, that learners have varying abilities to assume responsibility for their own learning, which may explain why teachers were found branching from descriptive to prescriptive monitoring strategies based on individualized interactions with students. Furthermore, McCombs and Whisler identify variables involved in the developmental process of becoming an autonomous learner:

> To become autonomous learners, students must develop various cognitive and metacognitive capabilities that allow them to actively process information, attach personal meaning to learning activities, and plan and regulate their own learning activities. At the same time, however, they must also develop cognitive and metacognitive capabilities for controlling and regulating affect and motivation. The development of these latter capabilities depends on the development of self-system structures (schemas for organizing self-knowledge, beliefs, values, and goals) and self-system processes (particularly self-awareness and self-evaluation processes related to personal competence and control). (p. 278)

A predominant theme, in the key incident reports written by the teachers and in their interviews, was the focus on transferring the monitoring responsibility from teacher to student over time. A primary characteristic of the instructional process that emerged from analysis of the CAI goals identified in the key incident reports was the dimension of writer autonomy, facilitating students' ability to fully engaging in discourse communities. This characteristic of the instruction is in keeping with the goals within the field of composition studies identified by many (Balester, Halasek & Peterson, 1992; Hawisher, 1990; Probst, 1990). David et al. (1995) explain: "But to become full participants in such [academic discourse] communities, students need a sense of themselves as writers which can best be developed in a writing course grounded in the assumptions [that] the development of writing ability and metacognitive awareness is the primary objective of a writing course. . . . The students' writing is the privileged text in a writing course. . . .The subject of a writing course is writing" (p. 525, 530). The goals of the curriculum under study aligned with these three assumptions about composition studies.

The collective data showed that the computer makes the cognitive processes associated with students' writing more concrete and explicit for both the teacher and the student. The computer's capacity to make visible previously undisclosed phenomena, in general, was recognized by Zuboff (1988). Zuboff coined the term "informating" to describe the computer-bound phenomena: "The consequences of the technology's informating capacity are often regarded as unintended. Its effects are not planned, and the potential that it lays open remains relatively unexploited. Because the informating process is poorly defined, it often evades the conventional categories of description" (p. 11).

The computer played a significant role in bringing to the foreground of the learning environment the students' actual writing process. The computer was used as a primary tool supporting an instruction approach that allowed the student to engage in process writing activities while the teacher observed and monitored those activities. Assignments drawing on the unique features of the computer were used during the sessions under study. Assignments used a number of word processing features to support student writing activities. These included the multi-file function to display an assignment file and a student workspace on one screen. Assignment files varied from types of models (i.e. prospectus, thesis statements, works cited examples) to exercises (i.e. sentence revision exercises, peer critique directions, question and answer prompts). Students were required to use columns to align argument and counter-argument points and the outlining function to their organize writing. They learned to use the revision tracking function to write and evaluate peer comments. They used the cut, paste, delete and insert functions to facilitate macrostructure revision and the spell checker, thesaurus, grammar checker, and readability index to facilitate microstructure revisions. During all these events, the teacher monitored the students' computer-assisted process and actually became involved in the process, while non-computerized process writing workshops are limited to analysis of writing products, i.e., drafts.

In the computerized environment, student engagement in writing activities freed the teacher to individually monitor and observe student writing progress. In addition, the emphasis on writing activity allowed the teacher to authentically compare students' achievement levels within a peer group. Ultimately, the computer facilitates the instructional process by challenging students to work independently as far as they are able on a given computer-integrated writing task. In this regard, the computerized setting under study facilitated proximal instruction aimed at fostering students' independent writing skills. In sum, the computer-assisted composition instruction provided a way for teachers to become closer to their students' skill development processes. At the same time, it brought to the foreground hidden characteristics of the writing process. These included reading comprehension, text analysis, vocabulary building, information researching, critical thinking, creative thinking, and computer literacy skills. Some characteristics of the proximal instruction process, as described in this report, deserve further research. Recommendations for further research include:

- The data suggests that prescriptive monitoring strategies foster skill development levels that are antecedent to those fostered by descriptive monitoring strategies; however, the critical junctures and the effects of the various monitoring strategies in relationship to students' developmental writing skill level needs further research.

- The association between teachers' monitoring cues and the learner's motivational propensity, extrinsic or intrinsic, was not verifiable by the data collected during this research project. Further research is need to uncover the nature of the motivational factors influencing writing skill development and self-monitoring.

- The effects of a teacher's monitoring in relationship to the development of a student's metacognitive monitoring skills for writing needs investigation.

This study describes a complex monitoring process used by teachers as they individualized their instructional approach in a computerized learning environment. Findings from this study may inform instructional system designs to assist teachers and student in collecting and monitoring the proliferation of data that emerges when students take an active learning role within the classroom. The next study addresses critical questions associated with designing computer systems for performance-based assessment.

Investigating Performance-Based Assessment Management Systems

The widespread concern that students in the American educational system are failing to learn critical thinking, problem-solving, and reasoning skills, and lack the ability to transfer these skills to authentic tasks has become a focus for our national educational reform agenda. "As it is now, students are rarely taught to learn how to learn - that is, how to 'manage' knowledge so as to effectively store and retrieve it for thoughtful, flexible use--nor are they assessed in such a way as to test their ability to manage available resources" (Wiggins, 1993, p. 84). "Learning to learn" incorporates the use of information and prior experiences in creative and imaginative ways, preferably in a risk-free learning environment that supports thinking. According to Wiggins (1993), this form of thinking is not widely encouraged; therefore, it is no surprise that the development of assessment processes to evaluate this form of thinking has not been a high priority. "Students learn to fear admitting ignorance or being creative. Questionable or imaginative responses, rather than being valued by students as the building blocks of thoughtful understanding, are viewed nervously as potential mistakes" (Wiggins, 1993, p. 73). In order to deal with these concerns, educators and psychologists have been researching various methods of improving both student learning and the assessment of student achievement. "Educational assessment is in a process of invention. Old models are being seriously questioned; new models are in development" (Herman, 1992, p.131). This view is supported by Wiggins (1993) as he cites Norman Frederiksen, a senior Educational Testing Service (ETS) researcher who states: "Most of the important problems one faces in real life are ill structured, as are all the really important social, political, and scientific problems in the world today. But ill-structured problems are not found in standardized achievement tests... We need a much broader conception of what a test is if we are to use test information in improving educational outcomes" (p. 4).

In the wake of concerns about standardized measures, individual teachers, districts, and states are developing new kinds of assessment measures based on performance outcome criteria. In order to gain the necessary assessment data that can provide teachers with accurate and useful information concerning student performance, teachers are turning away from traditional summative evaluation methods toward formative methods of assessment. These methods of assessment are known as authentic assessment, alternative assessment, and performance-based assessment. These terms are often used interchangeably with each other; however, they are not the same. According to Marzano, Pickering, & McTighe (1993, p.13), authentic assessment, popularized by Grant Wiggins (1989), conveys the idea that assessment should engage students in applying knowledge and skills in the same way they are used in the "real world" outside of school. Alternative assessment applies to the variety of assessments that differ from the multiple-choice, timed, one-shot approaches characterized by most traditional standardized and classroom assessments. Finally, performance-based assessment, according to Marzano, Pickering, & McTighe (1993, p.13), is a broad term encompassing many of the characteristics of both authentic assessment and alternative assessment. The Office of Technology Assessment (OTA) defines performance-based assessment of the U.S. Congress (1992) as "testing that requires a student to create an answer or a product that demonstrates his or her knowledge or skills". Performance-based assessment requires students to "do" something as opposed to taking an objective paper-pencil test. It zeros in on what a student's strengths are and what a student needs to learn, and requires students to actively accomplish complex and significant tasks based on experiential learning and relevant skills to solve realistic or authentic problems. "...Assessment(s) in context have 'ecological validity'--that is, students perform as they will have to in life" (OERI, 1990. p. 1). This assessment process is designed to present a broader, more genuine picture of student learning.

Performance assessment, as defined by Mitchell (1992, p. 20), is "a collection of ways to provide accurate information about what students know and are able to do or about the quality of educational programs." Assessment, therefore, should be seen as a motivational component to give both the teacher and the student the necessary feedback to enhance the learning process. Hence, "Assessment...becomes a part of the instruction, even when the results of assessment are also used for accountability" (Mitchell, 1992, p. 21). When assessment and instruction are viewed as a simultaneous process, as in performance-based assessment, the learner is provided with a clear understanding of the criteria necessary to confidently complete his/her task successfully. The establishment of an accepted set of criteria for the measurement of a performance-based activity or project requires standard procedures and/or methods in data gathering. The use of uniform procedures and/or methods for data gathering are not meant to place constraints on teachers' qualitative judgment of the content to be addressed in the assessment process. It is meant to help in identifying the basis of measuring or judging the process as well as the product of a student's activity. "An emphasis on content without process means honoring the ends, not the means, of education" (Costa & Liebmann, 1995, p. 23).

Classroom teachers find themselves in an instructional environment that demands that they face myriad changes in content, context, and delivery of information to students. These changes have affected not only the classroom instructional environment, but also have impacted management issues dealing with the collection of student assessment data. The ability to access assessment data from multiple sources in a time efficient manner and the ability to interpret, synthesize, and apply the information are rapidly becoming major challenges for the classroom teacher. The need to manage student assessment data is critical for effective educational diagnosis and is an important component in today's climate of academic accountability. The data gathering process for performance assessment must be consistent and systematic in order to acquire reliable and valid data concerning student performance. Performance-based assessment data is collected through the use of anecdotal records, journals, rubrics, portfolios, projects, presentations and/or interviews. This form of data gathering is complex, potentially massive, time consuming, costly, and is inherently difficult to manage with a class of twenty-five or more students. Therefore, if performance-assessment is to succeed, support for the classroom teachers to effectively collect and manage performance-based assessment is a strategic management issue facing the educational system.

An area that offers great potential for meeting the management problems created by the vast amounts of complex data is technology. However, in the search to find effective solutions, educators must be weary of vendors touting packaged solutions too quickly. Just as performance-based assessment is unique and complex, so is the process of collecting and managing the data. Through the use of technologies such as computers, computer software, scanners, and handheld PCs, the intricate process of collecting, managing and interpreting performance-based assessment can be addressed. Many software designers have recognized this educational market and have eagerly entered the educational field with various assessment management software programs. The majority of these programs are designed using database and/or multimedia programs. Both applications have the capability of solving the management issues involved in performance-based assessment. However, a major concern surrounding these management programs is many designers have only a surface level understanding of the intricacies involved in performance-based assessment as a component in the total schema of a classroom environment.

The classroom environment is unique to each class of students, school, and teacher therefore a performance-based assessment management system aimed at meeting classroom assessment management needs should include components geared towards the classroom. The purpose of this study is to examine the impact of technology on performance-based assessment and to determine ways to infuse it into the educational process in order to solve the management issues facing the classroom teacher. This study is intended for designers, researchers, administrators, technology coordinators, and/or classroom teachers interested in understanding the impact of technology on the management of performance-based assessment.

The research questions addressed in this study were 1.) How can technologies such as videos, computers, scanners, and others provide standardization of the assessment process, ensure time-effectiveness, and identify cost efficient methods for the facilitation of classroom management of performance-based assessment? 2.) How can technologies improve reliability and validity in the performance-based assessment process? 3.) What type of guidelines can be developed in order to: 1) provide standardization of the assessment process, ensure time-effectiveness, and identify cost efficient methods for the facilitation of classroom management of performance-based assessment? 2) improve reliability and validity in the performance-based assessment process?

Research Method

The methodology used in this qualitative research study was inductive analysis. Inductive analysis, according to Patton (1990), "...means that the patterns, themes, and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis" (p. 390). This research study was conducted in four stages to fully identify the patterns, themes, and categories of analysis.

First stage included an extensive literature review and document analysis that provided the framework for three sensitizing concepts to emerge. A more extensive research of the three sensitizing concepts provided indigenous typologies to emerge. The characteristics or attributes that comprise the indigenous typologies of the categories within the identified sensitizing concepts were then used as the criteria in a rubric. This rubric was then used in Stage Two and Three as an analysis tool. It was used to analyze five assessment software programs as well as provide a guide in the conversational interviews that were conducted. The interviewees included designers of software programs, consultants representing the five performance-based assessment software programs, and teachers who had either used or were currently using one of the software programs in the study. The data from Stages One, Two, and Three provided the foundation necessary for Stage Four, determining the findings of the study and presenting the results of the study, a set of guidelines for the management of performance-based assessment.

Research Findings and Discussion

The results of this study are proposed guidelines for the management of performance-based assessment. The design of the proposed guidelines is the result of a multi-level research process. This multi-level research process surfaced the information needed to develop comprehensive guidelines that utilize technology to effectively manage performance-based assessment and thus positively impact the work of the classroom teacher. The guidelines developed from this research consist of four basic components: (a) standardization of process; (b) time commitment; (c) cost; and (d) operational features.

Acknowledging and documenting the multi-dimensional learning, thinking and performance capabilities of all students engaged in performance-based tasks requires a practical and flexible assessment management system. The ability to systematically organize large amounts of complex assessment data is critical for the success of performance-based assessment. Therefore, the following guidelines have been developed to assist educators/administrators, technology coordinators, software designers, and/or researcher involved in selection or design of performance-based assessment management programs. The guidelines bring together the various components of performance-based assessment that range from obvious and commonplace issues to those that are somewhat technical and specialized. In addition, the guidelines provide a framework from which to determine the worth of an existing performance-based assessment system/program or to use as a guide in the development of a new program for effectively managing performance–based assessment. A graphic of the guidelines is located in Table 1.

The guidelines for the management of performance-based assessment consist of four basic components: (a) standardization of process; (b) time commitment: (c) cost; and (d) operational features. The first and most critical of these components is standardization of process. A performance-based assessment management program must have a consistent system that ensures validity and reliability in assessment situations as well as a historical or benchmark representation of student progress. In the proposed guidelines, the issues of accuracy, multiple samples, data gathering flexibility and consistency are addressed to ensure a valid assessment process that reflects what a student knows or can do. The issues of data entry, replication, historical review, and training are addressed to ensure the reliability of an assessment process. Reliability involves establishing a clear understanding of the criteria and standards to be used in the assessment process through the recording of assessment data using a rubric, anecdotal and journal notations, video clips, photographs, hand drawn pictures, or written reports. The ability to record assessment data using a variety of methods enables a deeper understanding of students' progress; it also gives a clearer picture of students' current, as well as historical, academic, and social progress. The ability to review student progress over time is a powerful tool in the academic and social development of the whole child. Capturing student progress through careful data gathering over time enables teachers to gain insight into the progress and development of students who, for example, may be struggling, may have recently moved into the school, or who may have exhibited changes in learning habits.

While the capability of multiple data entries allows for a more comprehensive picture of student progress, it can also negatively impact consistent replication of student assessment results. Preparing teachers to become more accurate and consistent in gathering and documenting assessment data is critical to the success of any performance-based assessment program. The need for accurate and consistent replication of assessment results drives major issues in developing a well-designed training program. A carefully and systematically designed training program supports teachers in the implementation of performance-based assessment and helps to ensure that the same rating can be replicated for a given student by another teacher at another time, thus supporting the reliability of the assessment program.

This systematic training can, in theory, increase teachers' confidence in their ability to utilize performance based assessment by providing both the tools and the skills to use up-to-date and accurate data in an effective way. As confidence grows, utilization expands and along with it follows efficiency, actually giving teachers time to reflect on the delivery of information, on content, or on a combination of the two. Engaging in an effective reflection process allows teachers to more clearly identify and modify educational goals in a timely manner, making adjustments to curriculum as the need becomes apparent. For years students have been given standardized tests, but the results were not returned to the classroom teacher until the following school year, too late to effect any changes which would positively impact student learning. Having the skills to use ready access to assessment information about the process, progress, and final product of students' work should greatly enhance teachers' confidence in their ability to make meaningful curricular adjustments and in their overall view of themselves as effective professionals.

The guidelines address time commitment on two levels: the time required to learn disciplined use of an assessment program, a potential perceived negative, and the time saved and accuracy gained by use of an assessment program, a clear positive. The first issue is addressed by devising a training plan with an appropriately designed learning curve so those teachers are challenged without being overwhelmed. The remaining, and most important, issue involves how teachers recognize the relevance and usefulness of a truly functional assessment management program. As teachers' data gathering and documentation skill levels increase, the amount of time required to collect and manage extensive amounts of assessment data will decline. They will begin to realize and welcome the power of systematically analyzing and utilizing assessment data for diagnostic purposes to improve the learning process, as well as to enhance accountability. Gradually, teachers will begin to understand the time saving value and the improved quality of information input and output with an assessment program designed with the use of the proposed guidelines.

Conceptually, standardization of process should be viewed as the critical component in the guidelines. Practically however, the critical component is often the initial and ongoing cost of the program. The proposed guidelines point out the need for a clearly defined cost structure that addresses the needs of single users and small or large school districts. Incorporating a flexible yet clearly defined cost structure provides single users as well as district users the option of customizing or phasing in a program. In this way, districts can purchase only what they need or can afford, thus optimizing the use of available monies.

Finally, the operational features of the guidelines are both practical and futuristic. The idea of connecting the schools electronically to the rest of the world opens up new educational frontiers for students to enter and learn. Connectivity offers the ability to learn in new and exciting ways with learning partners never before available to students in grades K-12.

Along with new learning opportunities, connectivity presents major challenges for the classroom teacher in effectively assessing learning in this new electronic learning environment. These assessment challenges can be met by first gaining a thorough knowledge of performance-based assessment. Initially designing assessments instruments to support and complement tasks performed in an electronic environment for students to achieve their goals will greatly enhance both learning and the assessment of learning. The systematic and organized integration of the components of connectivity into the assessment process will lay the groundwork for the next logical step, which is the connectivity of our schools to the vast possibilities of learning available to them through e-mail, bulletin boards, home pages, and the WWW. It also opens up a new vehicle for communication with parents, teachers, administrators, colleagues, community libraries, local government, etc. that will be of great practical benefit.

Theoretically, connectivity has the potential to both narrow and broaden communication between the home and school. It can narrow communication if parents and teachers resort to strictly "on-line" communication. The negative impacts of using only this form of communication are that 1) many individuals find it difficult to fully express themselves in written form, 2) the loss of face-to-face contact can negatively affect communication due to the inability to interpret subtle messages expressed through body language, and 3) if the conversation is not "live-on-line", the spontaneous reactions or attention may be lost, thus limiting communication. Connectivity can broaden communication through the ready access available to both parents and teachers "on-line".

Communication between teachers and parents is difficult during the school and workday. E-mail allows interested parties to send messages at any time that can be received and answered at a convenient time. Teachers can electronically send the same message to all students simultaneously or can write short notes to parents concerning the successes as well as difficulties of individual children to keep parents abreast of classroom activities and conduct. Finally, teachers or parents do not have to be in a specific location to communicate with each other. If a parent travels, he or she can log on to receive updates about their children's progress and respond from anywhere in the world. These positive and negative scenarios must be dealt with as a natural outgrowth of change. The pace of change is increasing at an exponential rate resulting in boundless opportunities for those who are prepared. Education should provide that preparation by forging ahead to set trends in learning that extend beyond the walls of the traditional classroom.

The assessment process is an integral part of learning and teaching. Performance-based tasks allow students to show the process as well as a final product of a learning situation. In this form of learning the assessment is no longer a mystery, but an understood standard by which to measure student work in progress. Demystifying the methods of assessment enables the learning process to take on new meaning. One where risk-taking is encouraged in order to extend critical thinking and reasoning skills beyond the expectation of "making a grade" based on recall and identification to an active, engaged performance or demonstration of ability. The methods involved in performance-based assessment are seen as tools in the learning process for both the student and the teacher in order to improve and encourage the process as well as the end product of learning.

Performance-based assessment is not a panacea; in fact, it holds many challenges for the educational community. If done in its true form, performance-based assessment generates large amounts of complex assessment data that require careful and systematic organization in order to assist with and measure student learning. The development of a performance-based assessment management program rooted in the proposed guidelines can be of great benefit in solving many of the challenges faced by the classroom teacher as well as in the overall learning process.

Students must be prepared to compete in the workforce of the future, adapt to diverse learning contexts, and collaborate with others on a variety of local and global levels. The ability to assess their own work in progress, as well as their own final product, will be an essential asset for the student of today and the worker of tomorrow to possess. "Workforce know-how will be part of the new World Class Standards. However, defining competencies and a foundation is not enough. Schools must teach them. Students must learn them. And, they should be assessed as part of the AMERICA 2000 agenda" (SCANS report for America 2000, 1995, p. 12).

Educational Implications from the Studies

In school districts implementing technology into the classroom, teachers find themselves faced with demands requiring changes in content, context, and methods of instruction. The research investigating teacher's monitoring activities a performance-based learning environment found that when learners become actively engaged in learning tasks a rich variety of learner characteristics and variables come to the foreground of the instructional arena. Learner characteristics emerge that are not readily apparent in traditional chalk-talk-textbook instruction where students play a more passive, receptive role. Because learning becomes more individualized, students must learn to metacognitively manage and direct their learning activities as much as they are able in order to be active participants in authentic learning tasks. The research suggests ways in which performance-based learning events can be structured so that teachers, students, and technology systems effectively assist the development of self-regulatory learning skills.

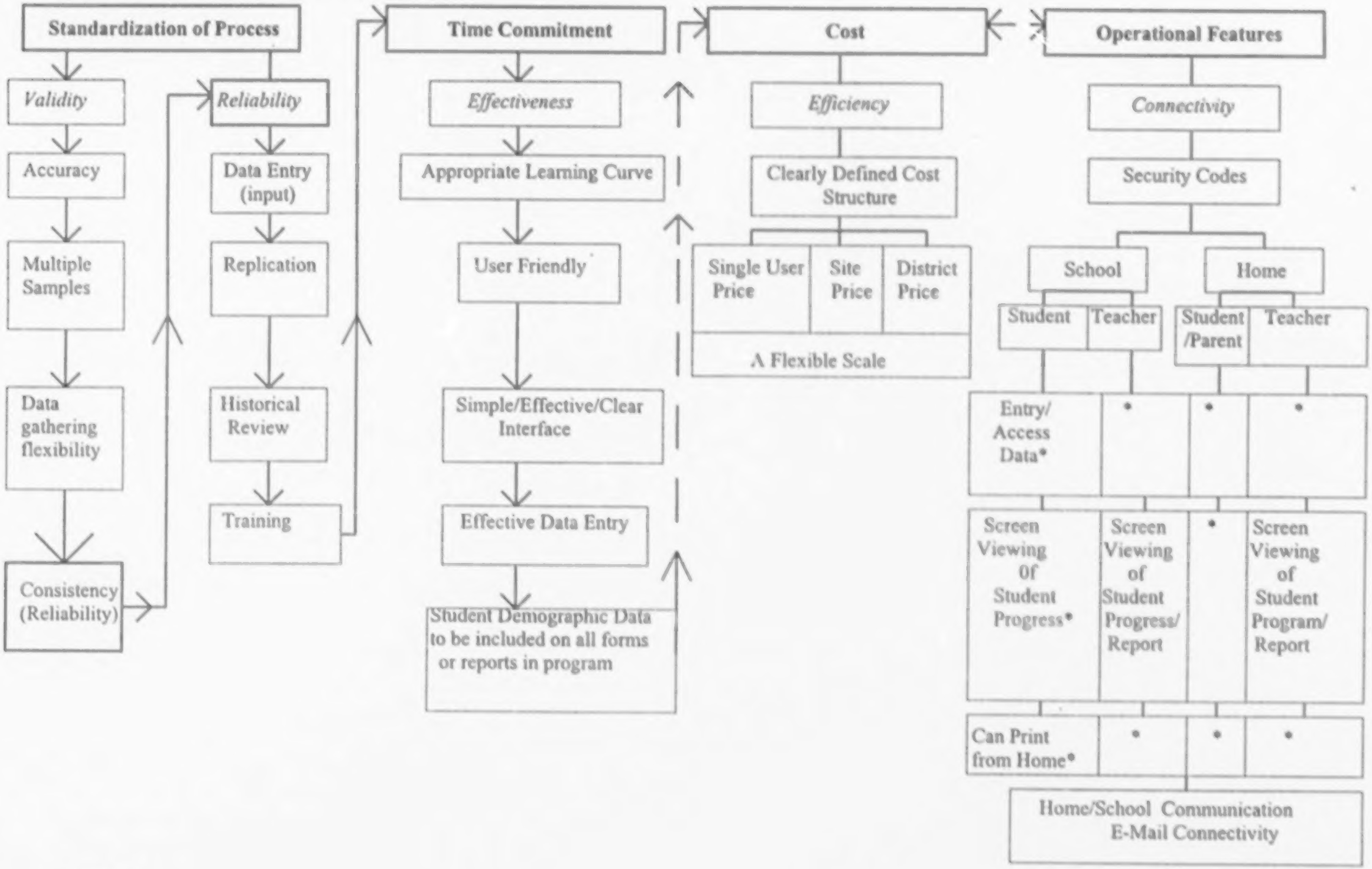
While authentic, performance-based learning tasks are associated with technology implementation, the changes that implementation cause in the classroom challenge the teacher with new classroom dynamics to manage. Proximal instruction describes instructional strategies for managing the social interactions within a computerized learning environment. Changes brought about by technology not only affect instructional methods, but also impact management issues related to student assessment of learning. The ability to archive, synthesize, interpret, and apply relevant assessment data from performance-based learning events in a time efficient manner is also a critical concern associated with implementation of technology in the classroom. The proposed guidelines derived from research bring together the various components of performance-based assessment that range from the commonplace to technical issues influencing the design, implementation, and utilization of performance-based assessment management systems that can greatly improve the overall learning process.

Performance-based learning is a complex, individualized educational approach that requires different instructional strategies and technological tools to support and properly implement. In this paper, the authors have presented research finding and draw the following conclusions.

- Technology systems need to be designed in congruence with teachers instructional approach in order to facilitate student's proximal development toward an instructional goal.
- The monitoring strategies and the system design guidelines presented in this paper need be contextualized to fit different instructional goals in different content areas.
- The descriptions of the proximal instruction process and the performance assessment system guidelines may provide interested individuals with insight into factors to consider when making instructional design decisions.

The research studies identify the need for technological solutions to provide efficient, valid and reliable information available to facilitate the types of instructional processes that accompany active, engaged learning experiences. The research studies identified the importance of designing flexible technology systems capable of supporting open-ended instructional approaches and providing contextual feedback to a wide variance of learners.

Table 1. Guidelines for the management of performance-based assessment.


Standardization of Process
Validity
Accuracy
Multiple Samples
Data gathering flexibility
Consistency (Reliability)
Reliability
Data Entry (input)
Replication
Historical Review
Training
Time Commitment
Effectiveness
Appropriate Learning Curve
User Friendly
Simple/Effective/Clear Interface
Effective Data Entry
Student Demographic Data to be included on all forms or reports in program
Cost
Efficiency
Clearly Defined Cost Structure
Single User Price
Site Price
District Price
A Flexible Scale
Operational Features
Connectivity
Security Codes
School
Home
Student
Teacher
Student /Parent
Teacher
Entry/ Access Data*
*
*
*
Screen Viewing Of Student Progress*
Screen Viewing of Student Progress/ Report
*
Screen Viewing of Student Program/ Report
Can Print from Home*
*
*
*
Home/School Communication E-Mail Connectivity

Appendix A

These guidelines emerged from analysis of the data during the first three weeks of the six-week study. Teachers were given updated guidelines on a weekly basis. The primary researcher generated the guidelines from analysis of the incoming key incident reports each week, until the key incident criteria reached saturation point. Each key incident addressed the following five questions.

Question 1: Describe the conditions in which your monitoring occurred. Elaborate on these conditions of the monitoring activity with respect to the aspect(s) of the assignment or the writing problem(s) your monitoring addressed.

- identify student's prior knowledge of concepts in the assignment;
- explain student's prior use of computer functions in the assignment;
- explain your familiarity with and purpose for using the assignment;
- indicate when other students listened to or observed the key incident.

Question 2: Describe your interactions with the student that embody your monitoring activity. Elaborate on the meaning of these interactions captured by the dialogue on the tape recording.

- identify who initiated the interaction;
- explain why the interaction was initiated;
- describe the focus of the interaction.

Question 3: Describe the monitoring strategies and tactics you used to instruct the student. Elaborate on these strategies and tactics that you intentionally used to intervene in the student's writing process.

- use action verbs that describe your monitoring activities, i.e. roaming, circulating, observing, reacting, intervening, questioning, probing, coaching, directing, prompting, supporting, motivating, suggesting, exploring, explaining, simulating, modeling, negotiating, goal-setting, mediating, challenging, etc.
- describe any combination of strategies you used with the student;
- define each strategy, i.e. the substance of the monitoring;
- describe your purpose for using each strategy, i.e. to detect, to diagnose, and/or to descriptively or prescriptively treat a problem the student is experiencing.

Question 4: Describe the consequences of your monitoring that are evident from the student's drafts. Elaborate on these consequences apparent in changes that occurred in the student's draft as a result of your monitoring activity.

- focus on the effect(s) of your monitoring on the student's computer-generated writing.

Question 5: Describe any self-monitoring you observed the student engaging in as a consequence of your monitoring activity. Elaborate on the student's self-reflection about the writing problem as a consequence of your monitoring.

- use action verbs such as articulating, reflecting, exploring, goal-seeking, goal-setting, goal-achieving, regulating, planning, organizing, generating, revising, evaluating, transferring knowledge, etc.

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Reflection as a Means of Developing Expertise in Problem Solving, Decision Making, and Complex Thinking of Designers

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Abstract

The paper attempts to reexamine the concept of reflection and reflective thinking as a means of developing expertise in instructional designers. It is argued that since the real world problems that designers face are ill-structured and ill-defined, designers must become reflective thinkers in order to define the problem, evaluate and examine relevant information and construct a plausible solution, acknowledging that the solution itself is open to further evaluation and scrutiny. In an attempt to describe conditions and strategies for promoting reflective thinking, two conceptual models are proposed and discussed.

The need for the reflective instructional designer

Most of the problems that instructional designers confront in their practice are unclear, unique and situation-based, and cannot be described with a high degree of completeness or solved with a high degree of certainty. These problems are different from well-structured problems that can be described completely and the solution can be identified as true or correct. In contrast to well-structured problems, ill-structured problems require the thinker to consider alternative arguments, seek out new evidence, or evaluate the reliability of data and sources of information (King & Kitchner, 1994). In order for designers to choose between competing ends and being able to solve the ill-structured, ambiguous and situation-based problems, they must reach to a level of thinking that is complex and reflective.

Simple logic or procedures are not adequate for solving the kind of problematic situations that are highly complex and context-based. Kitchner and Kitchner (1981) argue that in order to solve an ill-structured problem, the thinker must be reflective. A reflective thinker should hold the epistemological assumption that each solution may have some validity and may contain some errors, and that there may be no absolutely correct choice. The basic difference between this type of thinking and authority-based thinking or formal logic is that the first requires the continual evaluation of beliefs, assumptions and hypotheses against existing data and against other plausible interpretations of the data. It requires abductive thinking and reasoning. The resulting judgments are offered as reasonable integration or syntheses of opposing points of view, not a correct solution. This type of complex thinking is what Dewey also called reflective.

The importance of reflective thinking skills as a key element in designer's expertise and professional development is being recognized in the field of educational technology (e.g., Rathbun, Saito & Goodrum, 1997; Roland, 1994; Willis, 1995). New design practices and proposed design models which are based on constructivist interpretivist theory identify reflection as a major component of the processes of the decision making in design activities (Moallem & Earle, in press; Willis, 1995). Carefully articulated experiences that provide strategies for linking knowledge and action through reflection are becoming more common in the educational technology field. However, there has not been enough discussion and evidence about how to foster reflective thinking in designers. While it is obvious that using a recursive design model requires a reflective instructional designer who is able to think reflectively and reason adbuctively, more efforts are devoted to developing design models rather than to training reflective designers.

The purpose of this paper is to reexamine reflective thinking from different perspectives and upon reconceptulization of the term, propose a model for fostering reflective thinking and judgment among instructional designers. The paper also provides practical applications of the proposed reflective model in practice.

Reflective thinking: A re-examination

Reflection as controlled thinking

Dewey, the founder of the concept of reflective thinking in education, defines reflection as "active, persistent, and careful consideration of any beliefs or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends" (1933, p. 9). He explains that the origin of reflective thinking is a felt difficulty, a state of doubt or perplexity, which follows with the suggestion of some way out--the consideration of some solution for the problem. The data at hand, he says, cannot supply the solution; they can only suggest it. What then are the sources of the solution? Dewey (1933) indicates that past experience, a fund of relevant information, whether or not the thinker has some acquaintance with similar situations and materials at hand may help him/her to find some way out. However, unless there has been some analogous experience, confusion remains which urges the thinker to think and weigh the grounds on which the solution rests. Dewey further distinguishes between ordinary thinking and reflective thinking by emphasizing that the latter includes a "conscious and voluntary effort to establish belief upon a firm basis of evidence and rationality" (Dewey, 1933, p. 16).

Similarly, in an analysis of reflective thought process, Hullfish and Smith (1961) define reflection as controlled thinking which is guided by purpose and tends to be recursive. Basing their views on epistemological analysis that defines knowing as the interelatedness of memory, imagination and sentiency, Hullfish and Smith argue that "the raw data of experience (pure sentiency) are not objects of knowing" (p. 34). Rather that the interpretation of the raw data which is the result of the overtone of memory (past experiences) and imagination is. In their view, when the cues are meaningful (that is, the more related to the past experience) and recognition takes place quickly (instantaneous function of thinking which they call "a synthetic function"), there is no need to exercise conscious control of the thought process. But when recognition fails, even momentarily, the situation calls forth feelings of uncertainty and doubt which requires the individual to become aware of both "the analytic and synthetic functions of thinking" (p. 74). Thus, as with Dewey (1933), Hullfish and Smith call this feeling of uncertainty and doubt "the ground from which reflective thinking arises and a ground which intermingles emotional involvement and reflective thinking" (1961, p.36).

Reflection and tacit knowledge

In a more recent conceptualization of reflective thinking, Schön (1987) expands on Dewey's definition of reflective thinking by emphasizing the tacit or intuitive nature of knowledge and the ways of revealing it through self-reflection. Schön (1987) speaks of intuitive knowledge with a special focus on the knowledge that is tacit (knowledge in action). As compared to decision making models or even Dewey's notion of reflection, this type of knowledge/action activity does not rely on a series of conscious steps in a decision-making process. This knowledge is inherent, instead, in action; it is based, in part, on the past experience of the practitioner interacting with the particular situation. Schön suggests that knowledge in action is dynamic and unconsciously controls how we act in relation to problem situations. Schön (1987), also confirms that reflection occurs when there is a surprise, when something interrupts the flow of knowledge-in-action that guides our everyday activity.

However, Schön broadens the possibilities of reflection by suggesting that we deal with the surprise or feeling of uncertainty in two ways: "reflection-in-action" and "reflection-on-action" (Schön, 1987, P. 35). Reflection-in-action occurs while the thinker is engaged in an activity and is confronted with a surprise. In such case, the person frames and reframes the problem, comprehends its context, critically evaluates the underlying assumptions that led to the problem and constructs an alternative method of solving it which can be tested on the spot (Schön, 1987). Schön further distinguishes two forms of reflection-in-action. In the more formulatic form, the thinker uses the existing rules and procedures of practice to solve the problematic situation, and in the more elusive form, the thinker responds to the surprising findings by inventing new rules on the spot. Reflection-on-action, on the other hand, is retrospective and takes place after a decisive action. The major difference between reflection-in-action and reflection-on-action, from Schön's perspective, is that the latter does not have an effect on present action and the solution remains hypothetical until it is implemented.

Reflection and epistemic assumption

Recognizing that real world problems are complex and ill-structured, King and Kitchner (1993) elaborate on Dewey's and Schön's notion of reflective thinking by suggesting that situations may be problematic for a variety of reasons, such as the unavailability of, or the impossibility of, attaining data necessary for solving the problem. Individuals who do not recognize that such situations are truly problematic cannot make reflective judgments (King

& Kitchner, 1993). Emphasizing epistemic assumptions required for reflective thinking, King and Kitchner distinguish between reflective judgment and critical thinking, two terms that are sometimes used interchangeably, even by Dewey (1933, 1938).

King and Kitchner argue that critical thinking focuses on inductive and deductive logic skills, and assumes that learning logic or general problem solving principles and knowing how to use them will lead to critical thinking. By contrast, King and Kitchner explain, "rather than logic, basic differences in assumptions about what can be known and how knowing occurs differentiate authority-based thinkers from those who use reflective thinking" (King and Kitchner, 1993, p. 9). From their perspective, deductive and inductive logic cannot totally account for a naturally occurring, rational problem solving because a person may argue validity using formal logic, but still use authority as the basic criterion for truth. They further argue that problems that can be solved using deductive and inductive logic can also be described with a high degree of completeness, certainty and correctness (well-defined). Such problems do not require considering alternative arguments, seeking out new evidence, or evaluating the reliability of data and sources of information (Kitchner, 1983). However, real world problems that require reflective thinking are far from well-structured (Churchman, 1971). The solution to the ill-structured problems depends on how well the thinker is able to evaluate the logical strength of one frame of reference against another.

Reflection and abduction

Along the same line, Hullfish and Smith point to the power of abductive reasoning for solving ill-structured problems. They argue that while most of us are familiar with deductive and inductive reasoning, unfortunately, we tend to view these inferences as separate types of thinking instead of viewing them as movements arising within the total reflective process. They explain the differences between abductive inference and two other forms of inferences as follows.

> . . . In the situation calling for deduction we are confronted with two propositions believed to be related by implication. Our reason for reasoning is to infer the truth or falsity of one from the truth or falsity of the other. In the situation calling for induction we are confronted with materials which are believed to be a fair sample of a large class of familiar material. Our reason for reasoning in this instance is, to infer what is safely assertable about the whole class from what may be discovered about the sample. But in the case of abduction, we are confronted with facts, events, situations, and the like believed to be relevant to some interest, question, or problem. Our reason for reasoning now is to create, by inference, possible explanations for these facts (p. 120).

Hullfish and Smith conclude that hypothesis formation during reflective thinking process or abductive inferences is our initial hunch or idea, which constitutes our hypothetical solution for the problem raised. Using abductive inference, we attempt to order what is observed. In our attempt, we do not assume the existence of anything whose operation could not be observed and verified. It is thus that hypotheses are created, and these hypotheses direct the investigation that leads to the desired ordering. Within the investigation, Hullfish and Smith attest, both inductive and deductive inferences may function (Hullfish & Smith, 1961).

Furthermore, in the case of abduction, there is almost no guarantee for certainty, and so the principles of sound abduction in fact, are the principles of sound guessing (Shank, 1987). The guess or hypothesis that we select as the best is not necessarily the very best possible hypothesis on the subject, but simply the best that we have based on the available data. In other words, when confronted with an ill-structured problem, we find that many hunches or suggestions or hypotheses presents themselves, and we must select among them. In choosing among the hunches that present themselves, we progressively eliminate or modify any suggestion that does not account for the facts which would have to be regarded as relevant if the hunch is to be accepted as a working base. This type of thinking and reasoning calls attention to the fact that our knowledge of factual affairs is subject to possible revisions or rejection in the light of new evidence (all factual assertions are subject to modification as new evidence develops). It also indicates that our theoretical accounts are never finally verified and are subject to revisions or rejection when someone creates another way of structuring experience that proves to be even more useful. This form of thinking and inferencing may also be contrasted with the form in which one accepts a belief uncritically by relying upon authority without recognizing the modifications which new facts must introduce (Columbia Associates in Philosophy, 1923; King & Kitchner, 1993).

Reflection: A willingness to act

Reflective thinking is an emotional as well as rational process (Dewey, 1933; Hullfish & Smith, 1961, 1966; King & Kitchner, 1993). Both Dewey and Hullfish and Smith argue that emotions are central to reflective thinking. The individual becomes involved in only those problems he accepts to solve. Inevitably, therefore, "his biases, knowledge and values are vital factors in the reflection he carries on in problem situations" (Hullfish & Smith, 1961, p.109). Although reasoning gives the individual the ability to rise above any pattern of belief which is formed as a result of an unthinking or conditioning process (prejudice), the removal of prejudice is no simple matter. Prejudices are rooted in such deep feelings that it does not occur to us to question them. Due to our deep emotional attachment to a belief, we may avoid reflective construction of our experience by engaging in the act of rationalization. Sometimes rationalization takes the form of gathering considerable evidence to prove congruency for parts of the beliefs that were not incongruent in the first place. Therefore, reflection requires the thinker to be inclined to be thoughtful or reflective about the problem.

Reflection as a social practice

In a most recent analysis of reflective thinking, Zeichner and Liston (1996) criticize the way Dewey, Schön and others conceptualized reflective thinking. They argue that reflective thinking has been portrayed as a highly individualistic affair involving the thinker and the situation, and not a social process taking place within a learning community. Zeichner and Liston and several other scholars (Osterman & Kottkamp, 1993; Solomon, 1987), therefore, introduce the idea of reflection as a social practice and make the argument that our ideas/hypotheses become more real when we can speak about them to others. They further argue that the thinker should also be encouraged to reflect on the social context within which the problem situation exists. Recognizing the social context, they suggest, will lead the thinker to see how his problem situation is linked to other problems that exist in the institutional and social context.

In sum, it seems that what sets reflective thinking apart from other forms of problem solving and critical thinking is an individual's ability to not only reason abductively (Hullfish & Smith, 1961), but to willingly examine one's own beliefs or assumptions about the source of knowledge and the meaning of "truth" when faced with ill-structured problems (King & Kitchner, 1993). Furthermore, reflective thinking is an individual and/or social attempt to reorganize or reconstruct self as well as past experiences. It is the process by which the individual (sometimes in dialogue with others) comes to new understandings of his self, his actions, and his taken-for -granted assumptions.

A Reflective Thinking Model

Figure 1 presents a spiral model that summarizes the process and components of reflective thinking discussed in the previous section. The model assumes that reflective thinking is an insequential but purposeful mental activity. As shown in the model, according to Dewey, Schön and others, there are five phases of reflective thoughts (Columbia Associates in Philosophy, 1923; Dewey, 1933; Hullfish & Smith, 1961, 1966; Glaser, 1972; Schön, 1987): (1) Problem recognition or problem setting, (2) problem clarification or what Dewey called "intellectualization" of the problem, (3) hypotheses or suggestion formation and modification, (4) mental elaboration of suggestions, and (5) action taken on the basis of the best supported hypothesis or suggestion.

While these phases describe mechanics of the reflective process, six components explain the nature and dynamics of reflective thinking process: (1) Willingness to be thoughtful, (2) willingness to recognize and understand the context within which assumptions and the actions are formed, (3) willingness to explore and imagine alternatives, (4) the understanding and accepting of real uncertainty (epistemtic assumptions), (5) using abductive inference, and (6) being exposed to a variety of interpretive considerations (in dialogue with others). The phases and components of reflective thinking are interdependent. In other words, the ability to engage in the reflective thinking process depends on whether or not the components of reflective thinking exist.

As Figure 1 shows, reflection happens only if the designer is inclined to be about his/her beliefs. While thinking is natural, reflective thinking is not. A designer must be willing to consider his beliefs and engage in reflective thinking (Dewey, 1933; Grimmett, MacKijnon, Erickson, & Riecken, 1990; Hullfish & Smith, 1961; King & Kitchner, 1993). Without the disposition to engage in reflective thinking, designers will not be able to see issues from their client's view point. Furthermore, true reflective thinking presupposes that the designer holds the epistemic assumptions that allow him/her to understand and accept the real uncertainty and differentiate between well- and ill-structured problems of practice (King & Kitchner, 1993).

Willingness to recognize and understand the context within which designer's assumptions and the actions are formed is a major component of reflection (Brookfield, 1987; Zeichner & Liston, 1996). Contextual designers view their dearly held beliefs and values as, to some extent, social. They understand that value systems and behavioral codes are socially transmitted as well as personally generated by personal experiences. They are willing to acknowledge that their decisions and actions have an effect on their social context. The designer's willingness to realize that his/her personally devised values, beliefs, and moral codes are, in fact, culturally induced, results in forming hypotheses or suggestions that are context specific and broader in perspective.

Central to reflective thinking is the designer's capacity to explore and imagine alternatives to solve a problem situation (forming hypotheses and mental elaboration of hypotheses). When the designer realizes that there are alternative hunches (guesses, hypotheses) to a problem situation, he/she is skeptical of the claim to universal truth or to ultimate explanation. Such a designer scrutinizes and clarifies the problem by attending to the facts, events and situations that he/she believes to be relevant to the problem (abductive inference) instead of jumping to an inductive generalization. Of course, the question of which facts are truly relevant, is a matter of inquiry. When confronted with a performance problem, a reflective designer has many hunches or hypotheses. He/She then chooses among the hunches that present themselves by eliminating or modifying any suggestion that does not account for the facts which would have to be regarded as relevant if the hunch is to be accepted as a working base (Hullfish & Smith, 1961). However, the reflective designer realizes that the chosen hypothesis is still hypothetical and subject to continual modification in the process, or even to replacement. This form of thinking which Shank (1987) calls "acts of skill" instead of reasoning, (p. 279), can be the source of the designer's creativity (Peirce, 1955) because it helps him/her to move back and forth from facts to theory and theory to facts.

On the basis of the best supported hypothesis or hunch, a reflective designer must take an action and seek confirming evidence, which can leave him/her to make the judgment or come to a resolution for the problem. As Schön defines in his reflection-in and on-action, the designer should have the opportunity to experiment with the actual operation of his/her solution before determining practice (reflection-in-action). However, there are times that the designer cannot experiment with the actual operation of his/her conclusion (reflection-on-action). In such cases, the closing of reflective process incident comes only after the experimental verification (Schön, 1987).

Three aspects of reflection: From theory to practice

Emphasizing the importance of reflection as a key element of designers' creativity and professional growth, the preceding model was used to identify three aspects that are essential in fostering reflective thinking in instructional designers. These three aspects are:

- Self-reconstruction (understanding of assumptions underlying thought and action)
- Action-reconstruction (new understanding of the problem situation)
- Social-reconstruction (reexamining taken-for-granted assumptions about design and development)

For each of these aspects, it is assumed that the source of knowledge for reflection is both found in the context of action and in the practical application of personal knowledge. It is also assumed that puzzlement and subsequent reflection about a situation or presuppositions that guide action in it, lead to a mode of knowing described by Grimmett and others (1990) as "dialectical" (p. 27). In this view, knowledge is seen as emergent, that is the designer reframes and reconstructs past understanding in such a way as to generate a fresh appreciation of a practice situation (Schön, 1987). Each of the three aspects are subsumed under these assumptions.

Self-reconstruction

This aspect of reflection is focused on the individual's view of himself/herself as a designer (what it means to be an instructional designer). In this aspect, future designers perform a personal search to become more aware of the cultural milieu in which they operate. Van Manen (1987) describes three ways in which the idea of self-reflection can be used: self-reflection as an ontological phenomenon, self-reflection as a life philosophy, and self-reflection as a methodological concept. As an ontological phenomenon, self-reflection is concerned with ways of being in the world (Grimmett et.al, 1990) and with how we come to understand our own existence. Self-reflection as a life philosophy focuses on individuals' understanding of themselves through life and life experiences. Finally, self-reflection as a methodological concept refers to being attentive and thoughtful to the relationship between theory and practice. Self-reflection from this perspective means being able to develop and provide warrants for our own beliefs and interpretations. Generally speaking, the three levels of self-reflection provide designers with an opportunity to shape and restructure their tacit knowledge and beliefs about design and development which will directly impact the way they think and the way they make judgments and decisions.

Action-reconstruction

In action reconstruction, designers reframe actual problem situations in a manner which leads to new insights about design theories. The process of reframing the experience will lead to a new way of seeing the situation (learning to think abductively). Based on this aspect of reflection, designers learn to examine the existing problems of design practice abductively and conceptualize needed changes based on reflection-in and on-action. In this aspect of reflection, designers learn to understand and examine a variety of contexts ranging from face-to-face interaction with expert designers, developers and clients to social and political forces influencing what goes on in settings. In order to understand and deal with situations, designers identify the cultural context of the problem and engage in generating alternative perspectives.

Social-reconstruction

Social-reconstruction refers to the aspect of reflection that requires designers to identify and address the social, political, and cultural conditions that frustrate and constrain empowerment and self-control. This aspect of reflection discovers those beliefs or behaviors which preserve the inadequacies of the current system and prevents the introduction of new ideas and better approaches in instruction. By involving designers in critical reflection, designers will make explicit for themselves the intentions and underlying assumptions, knowledge, values, and sensitivities that guide the design practice.

Promoting reflective thinking in instructional designers: Strategies and suggestions

Each of the three aspects of the reflective thinking approach suggests conditions and strategies that can promote different components of the reflective thinking process. The reflective thinking approach differs from the traditional learning theory approach in developing expertise in designers. While in traditional learning theory approach, specific techniques of analysis and learned rules of practice are emphasized, the proposed reflective thinking approach is grounded in the designers' own internal rules for making sense of the experiences. Furthermore, the reflective thinking approach to developing expertise includes designers' personal understandings of practice situations. This form of knowledge construction requires an engagement in authentic cognitive activities in which the novice designer is challenged by a mentor through constant dialogue and sharing of the experiences. This kind of environment not only resembles the every day social setting in workplaces, but it also helps designers become reflective in the analysis of their own actions through the cycle of reflection consisting of problem setting, reframing (clarifying the problem) and resolution. This form of knowledge construction also requires a learning environment in which novice designers are constantly encouraged to question the validity of their presuppositions and the relationships between these assumptions and the social, political and cultural conditions. Thus, a cognitive apprenticeship model (Collin, Brown, Newman, 1989) accompanied by assistance or "scaffolding" from mentors, creates the best conditions for reflective thinking. The following section looks at a number of strategies that can be used to promote reflective thinking in instructional designers. It must be noted that the role of mentor or expert designer is critical in promoting all aspects of reflective thinking.

Strategies to facilitate self-reconstruction

Self-reconstruction can be best facilitated within an apprenticeship model in which the mentor helps the novice designer to reflect on his/her underlying assumptions upon building trust and self-respect. The mentor may assign mysterious tasks, introduce contradictory ideas, question tacit assumptions, or refuse to answer questions in order to create disequilibrium. The mentor can also create the conditions in which designers ask critical questions about why people think and behave in the ways they do, how people come to know something (epistemology of knowledge) and what the relationship is between what they think and what they do. Another condition that can promote self-reconstruction is called critical incident, a technique that was first introduced by Flanagan more than forty years ago (1954). The focus of the critical incident is on the events that are of particular importance to the thinker. Critical incidents provide expert mentors with hunches as to what are the most significant concerns and assumptions of the novice designers. They are also important because they encourage designers to talk about themselves without being consciously aware of it. For example when a designer criticizes other designers' actions as inappropriate, he/she is saying something about his/her own conception of practice. Identifying and analyzing the validity of assumptions influencing design practice and critical debates are also conditions that can promote self-reconstruction. While critical analysis helps designers develop criteria for evaluating their beliefs and assumption, critical debates will assist designers to take an unfamiliar perspective on an issue or to explain in a sympathetic manner a position with which they disagree.

Strategies to develop action-reconstruction

Although the spiral model of reflective thinking may suggest an overemphasis on the procedures of logical thinking, the whole reflective process is far messier than four or five stages. For example, the designer may move back and forth between problem situation and analysis of alternatives many times before reaching a tentative conclusion or solution. Moreover, anywhere during the process the designer may have an insight that suggests a reconfiguration of all parts of his/her previous deliberation; after much consideration, no alternative may appear warranted, yet the designer needs to choose an action; or new circumstances may develop causing the designer to temporarily stop the process. Thus, reflective thinking requires both rational and intuitive thought process. Promoting such thinking requires authentic activities in which designers face the real world problems of practice. Simulated cases in which novice designers work in groups to simulate real world problems and the process of solving them will facilitate their abductive reasoning skills. Reflective discussion must follow the simulation cases to provide designers with formative feedback and to encourage them to engage in self-assessment. Varying both the degree of complexity and the uncertainty of the simulated cases will allow for a gradual development of reflective thinking. Another strategy that can provide the proper conditions to promote reflective thinking is participate in a real design activity. Engaging in real tasks of analysis, design and development and working directly with clients provides the best opportunity for novice designers to test their theories in action. Such activities will not only help designers to tests theories, but also to realize the dissonance between what they say they believe in and what they suspect to be true. During these activities, designers should be encouraged to use ethnographic or interpretive techniques and to reflect on the reasons why specific theories are not working and to seek alternative forms of practice. This reflection-in-action must be followed by reflection-on-action in which designers engage in identifying assumptions underlying specific theories and considering the fit between these assumptions and the reality of professional practices. One process that must be emphasized in real world problem solving activities is that of the problem setting (Schön, 1983). Designers must realize that in real world practice, problems are defined by their participants rather than external authorities. The problem setting, therefore, is grounded in designers' contextual awareness of the important aspects of the workplace life.

Strategies to develop social-reconstruction

The uncovering of assumptions underlying organizational cultures, and the discovery of the connections between policy decisions, legislative change, and designer's decisions are probably the most untouched areas of reflection. Designers must have the opportunity to discover the issues of control and power and how they are affecting people's personal relationships. Questioning the basis on which individuals, groups and systems exercise power and making connections between isolated incidents and broader political happenings is the heart of the reflective thinking approach. Without this realization, design efforts will become re-active instead of pro-active. Activities such as asking novice designers to speculate imaginatively on alternative ways of distributing power, or how hierarchies might be dismantled and structures changed in an organization could facilitate understanding of the social and political connections with individual design efforts. Conducting an analysis of the culture of organizations which is based on actual data, analysis of personal biographies in light of how individuals have assimilated dominant cultural values, providing experiences of practicing the democratic process of decision making and asking questions about why power and wealth are distributed the way they are, are some of the useful strategies.

Conclusion

In this paper, I have attempted to reexamine the concept of reflection and reflective thinking as a means of developing expertise in instructional designers. I have argued that since the real world problems that designers face are ill-structured and ill-defined, designers must become reflective thinkers in order to define the problem, evaluate and examine relevant information and construct a plausible solution, acknowledging that the solution itself is open to further evaluation and scrutiny. In an attempt to describe conditions and strategies for promoting such thinking processes, I proposed a conceptual model which led me to identify three aspects of the reflective thinking approach and suggest a number of strategies for promoting each aspect. The reflective thinking approach proposed opens a new way of educating and training instructional designers which is consistent with new conceptualization of the instructional design models and with the constructivist learning theory. Although much more must be learned and discussed in this area, reflective thinking approach has obvious implications for the instructional design field.

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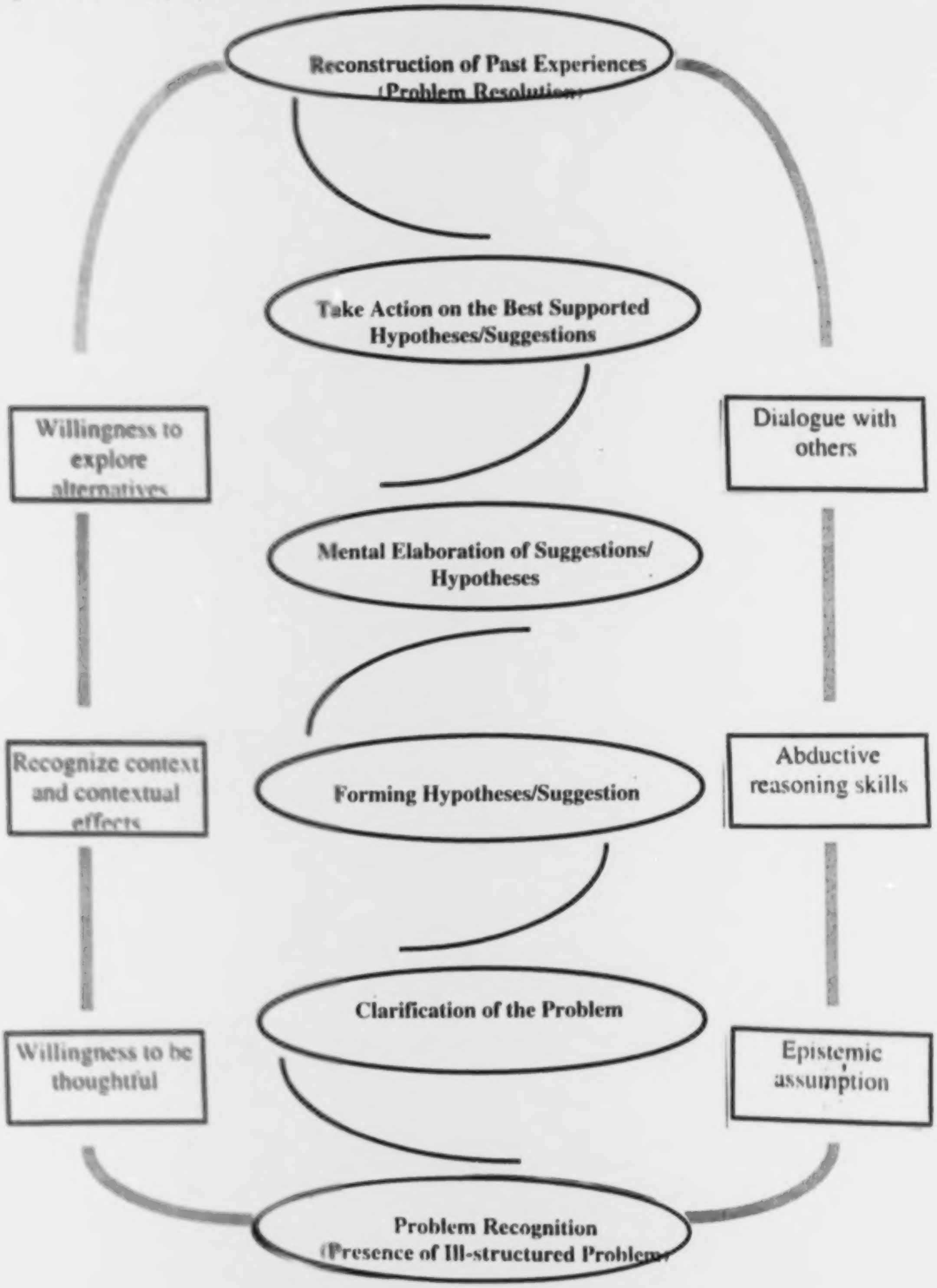
Figure 1: A Model of Reflective Thinking



Reconstruction of Past Experiences
(Problem Resolution)
Take Action on the Best Supported Hypotheses/Suggestions
Mental Elaboration of Suggestions/ Hypotheses
Forming Hypotheses/Suggestion
Clarification of the Problem
Problem Recognition
(Presence of Ill-structured Problem)
Willingness to explore alternatives
Recognize context and contextual effects
Willingness to be thoughtful
Dialogue with others
Abductive reasoning skills
Epistemic assumption

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Effect of Color-coding on Locus of Control

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Introduction

As a psychological construct, locus of control describes a condition when people enter into a situation with certain expectancies regarding the probable outcome of their behavior. Expectancy and reinforcement are therefore brought together in a working construct. A determinate within this framework is the degree to which a person feels that they possess (internal control) or lack (external control) power over what happens to them (Rotter, 1966). The use of visuals in instructional materials offers potential for subjects to control their immediate learning environment by selecting or attending to certain visual aspects within a visual.

Research has shown that color-coding instructional materials helps learners organize or categorize information into useful patterns which learners interpret and adjust to their environment. Color-coding may be considered a strategy with which students enhance or sharpen essential message characteristics by providing structures for the interpretation of new information (Dwyer, 1978) If visualization and the use of color-coding provides reinforcement to learners (particularly those of high or external locus of control), color coded materials may be a positive factor in attempts of learners to control their visual learning environment. The purpose of this study will be to examine the effects that color (b/w and color) has on the information processing strategies of the internal and external locus of controlled learners. It is the primary hypothesis of this study that the color coding will significantly improve the students identified as being external locus of control. It was anticipated that the color-coding of concepts and processes would help "externals" recognize and encode imprint concepts and processes leading to greater understanding of the information presented and subsequent achievements.

Literature Review

Locus of control has been defined as a form of self-appraisal related to the degree to which individuals view themselves as having some causal role in determining specific events. Rotter's (1966) Internal-External Locus of Control Scale separates individuals into two perceptual groups (a) internals being individuals who perceive their behavior as being directly related to outcomes, and internals who perceive outcomes as being dictated by chance, luck or circumstances outside of their control (Rotter, 1966; Joe,1971). Hersh and Scheibe (1967) and Gozali et. al. (1973) found the reliability of the Internal-External Locus of Control Scale to range from 0.70 to 0.80.

Observations from prior research indicates that: externals preferred chance situations over skill situations (Feather, 1967); internals actively seek information relevant to problem solving (Davies & Phares,1967). Internals tend to retain, learn, remember and attend to more information, especially when the information is related to personal future goals (Long, 1979). Internals are more active information processors and are able to better use previous information in decision-making tasks (Pines, 1973). Internals also believe that reinforcements are contingent upon their own behavior, capacities, or attributes. Externals believe that reinforcements are not under their personal control but rather are under the control of powerful others, luck, chance, and fate (Rotter, 1966; Joe,1971). Internals are generally more concerned with their abilities and their failure (Efran, 1964). They seem to have greater need for independence and are resistive to subtle attempts at influence (Crowe & Liverant, 1963; Strickland, 1963).

Statement of Problem

Prior research has found that color-coding to be an important instructional variable in facilitating student achievement (Dwyer; 1978, 1987); its instructional effect on two learning stages (Internals and Externals) constituted the focus of this study. Since students processing the different learning styles perceive and process information differently, different levels of visualization (black and white and color coded) were used in order to determine the most effective level in facilitating achievement for both learning styles. Specifically, the purpose of this study was to (a) examine the instructional effectiveness of two types of visualized instruction in facilitating student achievement for students identified as possessing different styles of learning (Internals and Externals); (b) determine whether an interaction exists between types of learning style and instructional treatment, and (c) determine whether specific instructional treatments were equally effective in facilitating the achievement of I-E students on specific educational objectives.

Methods and Procedures

One hundred and seven college students were classified as external, neutral or internal locus of control based on their scores on the Rotter (1966) Internal-External Locus of Control Scale. Students were identified as external, neutral or internal by separating the performance are one half standard deviation above and below the mean. This process resulted in thirty-six students being identified as externals, fifty-five as neutral and twenty -six as internals. The instructional content employed in the study was the anatomy and functions of the human heart during the diastolic and systolic phases. The instructional unit also contained 19 visuals positioned as a result of item analysis. The instructional booklet included one page of directions and twenty pages of concepts and functions of the heart integrated by prose text with accompanying visualization. Directions on the first page of the booklet indicated to the students that the materials were part of an investigation to study the relative effectiveness of visual illustrations accompanying printed instructions and that there was no time limit. For purposes of this investigation, six color categories and black were used to code the heart concepts (See Table 1). Printer's ink colors selected were from Pantone Matching Systems.

The six colors were: red (Pantone---warm red, blue (Pantone ----process blue), green (Pantone--green), purple (Pantone--No. 227), brown (Pantone--No. 471) and gold (Pantone--No. 124). The black (Pantone--black) was used for all the non-color coded design elements within the color coded materials and for all the design elements within the black/white material.

This scheme of color coding application to central concept sequences and the lack of the color code in peripheral sequences insured that the color code: (1) was used only to emphasize the central concept being presented; (2) was used to structure a large number of heart concepts into smaller category groups; (3) was used to differentiate dissimilar concepts; and (4) was used to contextually (physical form) and semantically (associative value) relate similar concepts or functions. The scheme of color coding application to the instructional sequence also insured that: (1) peripheral learning was not emphasized; (2) a contexual color cue was not continuously conditioned; and (3) an association was not based purely on semantics.

Thus the black/white instruction: (1) could not visually emphasize central from peripheral concepts within the prose text; (2) could not visually structure a large number of heart concepts into smaller category groups; (3) could not visually differentiate dissimilar concepts; and (4) could not contextually (physical form) relate similar concepts or functions. The black/white instruction, while having similar contextual cues (word labels, arrows, and shaded areas), relied primarily on the learner's associative ability to categorize and relate word meanings.

Treatment 1. Students in this treatment received the 1800 word instructional unit complemented by the 19 black and white visuals.

Treatment 2. Students in this treatment received the identical prose instructions and visuals as did students in Treatment 1; however, their (19) visuals were coded according to the scheme presented in Table 1.

Table 1. Scheme of Color Coding Application to Instruction and Test Materials.

Color Code	*Heart Concepts*[a]
Red	right auricle; left auricle; epicardium; auricles; diastolic; lowest pressure; contract; relaxation; arrows[b]
Blue	right ventricle; left ventricle; myocardium; ventricles; systolic; greatest pressure; pressure is greatest; contract; contraction; arrows[c]; arrows[d]
Green	tricuspid value; mitral value; endocardium; apex; valves; opened; opens; partially open; partially closed; closed; closure; hashing and brackets[e]
Purple	pulomary value; aortic value; semi-lunar valves; valves; tendons; open; close; closed
Blue	superior vena cacva; inferior vena cava; pulomary veins; pericardium; vena cavas
Gold	pulomary artery; aorta, aortic artery; septum, arteries
Black	body; lungs; heart[f]; arrows[g]; misc.[h]
Red	ectoderm; venic value; arteries
Blue	----
Green	Vascular space; parasympathetic
Purple	semi-lunar chamber; semi-lunar value
Brown	pulomary vein; inferior vena cavas; superior vena cavas; sympathetic; veins, extoxin
Gold	aortic base; aortas; pulomaryarteries; ectocardium; sympatric; cardiac artery; septic value
Black	none of these; misc.[h]

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[a] Most colored heart concepts had an identical color arrow(s) extending from the concept word to the concept visualized; some colored heart concepts had identical colored areas representing visually the concept word.

[b] Arrows were designed to visually illustrate auricle contraction.

[c] Arrows were designed to visually ilustrate ventricle contraction.

[d] Arrows were designed to visually illustrate the first and second contraction during the systolic phase.

[e] Hashing and brackets were designed to visually illustrate the area representing the concept apex.

[f] The heart was visually represented by a simple line drawing.

[g] Arrows were designed to visually illustrate blood flow and blood pressure against the heart values.

[h] Some correct and distracter items were black in the comprehension task.

Criterion Measures

Rotter's Internal-External Locus of Control Scale was used to identify the degree of externality among students participating in this study. The scale consists of twenty-nine fixed-choice items, six of which are filter items. Immediately upon completion of these respective instructional modules, each student completed four individual criterion measures. Following is a brief description of each.

Drawing Test

The drawing test assesses the students' ability to construct the heart in its proper context. The students will draw a representation of the heart and label the parts with numbers that correspond to a list of 20 parts given the test, for example, the epicardium, aortic valve, septum, and pulmonary veins. The test was evaluated for correct visual placement of the parts.

Identification Test

This test evaluates the students' ability to identify the parts of the heart from supplied drawings of the heart with four or five letter labels pointing to various areas of the heart. The purpose of the test was to measure the students' use of visual cue to discriminate different structures of the heart and connect proper names of the heart with the location of the part.

Terminology

The test was designed to measure the students' knowledge of facts, terms and definitions. The objectives measured can be generalized to any content area where basic elements are a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test

This test measures the students' ability to evaluate the functions and the position of certain parts at a particular time when the heart is functioning. The student must understand the parts of the heart, their function, and the simultaneous process that takes place during the systolic and diastolic phases. The purpose of the test is to measure understanding in order for the student to explain some other event.

Total Criterion Test

The items (80) given in the drawing, identification, terminology, and comprehension tests were combined to give a total achievement score.

Results and Discussion

The 2x3 analysis of variance design was analyzed for its main effects and interactions. The main effects were the locus of control and color coding. Table 2 illustrates the number of students in each comparison along with there respective mean achievement scores and standard deviations on the total criterion test and Internal-External Locus of Control Scale for the different comparisons.

Results indicated that a significant main effect existed in favor of the color-coded treatment on the total (F=11.01, d_f=^{1}/1111p.<.05) identification (F=4.66,d_f_^{1}/111, p. (.05) and the drawing (F=45.3, ^{1}/111, p. <.05) criterion measures. Insignificant differences between the black and white and color coded treatments were found to exist in the terminology and comphrehesnion tests. Insignificant differences were found to exist among levels of Locus of Control (high, medium, low) (F=1.41, d_f=^{2}/111, p.>.05 and color coding and Locus of Control (F=58, d_f=^{2}/11, p.> .05. The Locus of Control variable did not have a significant main effect in facilitating student achievement in terms of their ability to generalize and perform on the total criterion test. In general, the Locus of Control variable dichotomizes individuals who take responsibility for their own meaning and those who do not. These insignificant achievement results may be partially examined by the fact that college students were used as the experimental population. Although they were divided into internals and externals based on their performance on the Rotter I-E Scale, the dichotomy itself may have been artificial. Since most college students have already exhibited internal characteristics (being of the belief that industrious behavior-study will lead to success) the division (one half standard deviation above and below the grand mean) many separated internals into two groups called internals and externals. Under these circumstances it was unrealistic to expect significant differences to reveal themselves in terms of increased performance. Another possible expectation for the inability of the different levels of locus of control to perform differentially on the total criterion test might be the first that students did not realize that the colored illustrations they were receiving were colored-coded according to a specific rationale (system). Had they been aware of the system their performance may have improved significantly.

Table 2. Means and Standard Deviations for all Comparisons

	N	M	SD
Treatment 1	58	59.85	12.27
Treatment 2	59	50.42	14.56
Locus of Control			
Low	36	54.75	13.01
Medium	55	53.55	15.84
High	26	58.85	11.84
Locus of Control (B & W and Color Coding)			
Color/Low	20	58.4	11.81
Color/Medium	26	60.00	13.10
Color/High	12	61.92	11.88
B & W Low	16	50.18	13.36
B & W Medium	29	47.75	16.04
B & W High	14	56.21	11.57

The significant main effect indicating that students who received the color coded instructional treatment achieved significantly higher scores on the identification, drawing and total criterion test than did those students who received the black and white indicates that color remains to be a important instructional variable in improving student achievement. The findings of this study emphasize the importance of the interrelatedness of variables associated with learning and the effective use of visualization in the teaching learning process. It verifies the fact that visualization in the instructional process functions not as an isolated phenomena, but an interrelated constituent process operating at varying levels of complexity--the elements of which acquire significance only in the context in which they are used. The explanations introduced and their implications should be carefully evaluated by instructional designers and researchers for further research into the more effective design of visualized instruction.

Note: This Presentation was based upon an article submitted to the *International Journal of Instructional Media*.

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Interaction and Collaboration via Computer Conferencing

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Abstract

Computer conferencing is becoming an increasingly important tool in university course delivery. This study addresses ways in which computer conferencing impacted interaction and communication patterns among students and with the instructor in a graduate course. Primarily through qualitative research methods, we address the use of a widely used computer conferencing software program in an academic setting. We also identify instructional and learning strategies in a constructivist paradigm, and we analyze the instructor's role in computer conferencing.

Introduction

Networked computers have been used in academic course delivery in the United States since as early as the 1980s, and their use grew significantly in that decade. Hiltz (1994) describes a Virtual Classroom™ as a teaching and learning environment located within a computer-mediated system. Rather than being built of bricks and boards, it consists of a set of group communication and work "space" and facilities, which are constructed in software (p. 3).

A number of studies have examined the benefits and challenges associated with this educational delivery system (Berge, 1997; Burge, 1994; Harasim, 1990; Hiltz, 1994). Key benefits of computer conferencing include providing equal access for interaction, fostering collaboration, allowing for learner reflection, and supporting learner interaction. Challenges to the use of computer conferencing include unequal access to hardware and software, a steep learning curve, the reliance on text-based communication, and managing large amounts of information and communication.

Computer conferencing has been used in university classes as an adjunct to face-to-face and distant delivered instruction (Murphy, Cathcart, & Kodali, 1997; Yakimovicz & Murphy, 1995) as well as the primary mode of communication (Eastmond, 1995; McIsaac & Ralston, 1996). These university settings provide powerful evidence of the ways that computer conferencing is used to provide opportunities for collaborative learning and sharing of multiple perspectives, both of which are integral to constructivist learning environments (Wilson, 1995).

Of the many computer conferencing software programs available, FirstClass™ (FC) is currently the most widely used (Bates, 1995). The FC environment provides for discussions on organized topics, uploading and downloading files, real-time text-based chat rooms, conference messages, collaborative document writing space, and private email. All of these functions were used in the class and examined in this study.

This study addresses the manner in which computer conferencing enhanced communication and interaction patterns among graduate students in a course offered at a distance. We identify the capabilities and challenges of computer conferencing, and we address the similarities and differences in the use of computer communication and face-to-face interaction strategies. We also describe how the medium of exchange in computer conferencing encourages online discussion and fosters collaborative learning. We examined the instructor's expanded role in the computer conferencing environment.

Theoretical Framework

Constructivism is the paradigm or world view that recognizes learning as the process of constructing meaning about, or making sense of, our experiences. Qualitative researchers "attempt to understand the meaning of events and interactions to ordinary people in particular situations" (Bogdan & Biklen, 1992, p. 34). Through working in collaborative groups (Brown & Palincsar, 1989) and learning in authentic environments (Brown, Collins, & Duguid, 1989), learners are encouraged to develop personal meaning. Computer conferencing is increasingly the means by which "learners actively construct knowledge by formulating ideas into words that are shared with and built upon through the reactions and responses of others" (Harasim et al., 1995, p. 4).

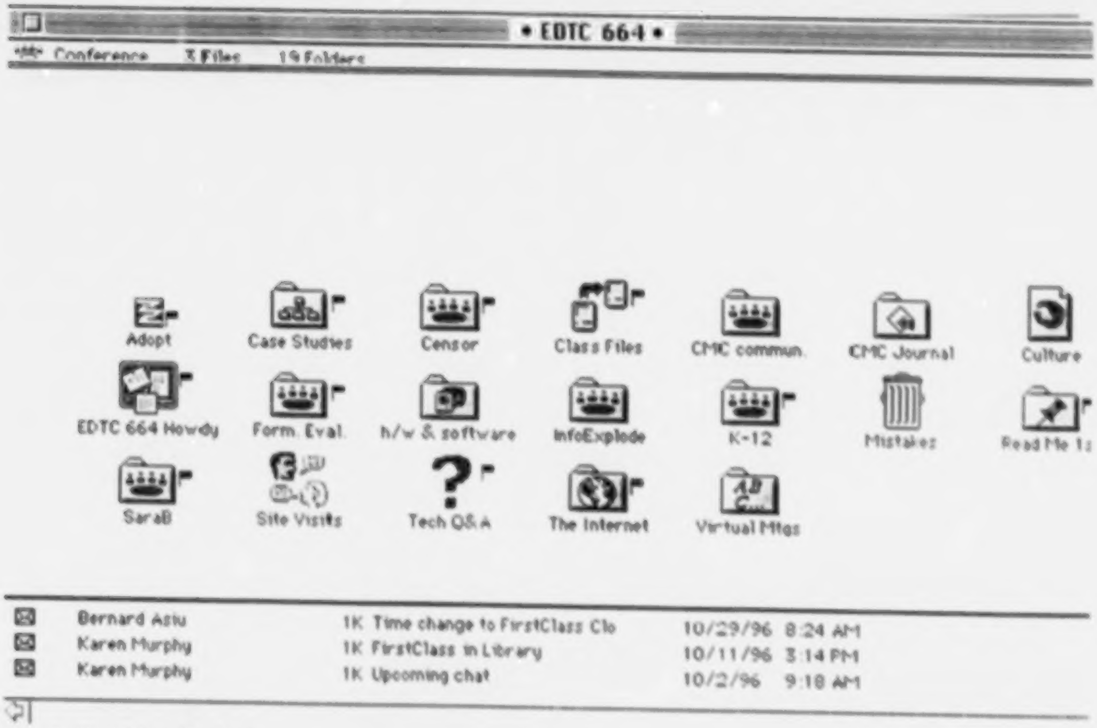
Garrison (1989) identifies two-way interaction as a critical feature of the educational process. In a computer conferencing environment, this communication takes place via technology and is embedded in instructional methods that provide for interaction (Wagner, 1994). Interaction is necessary not only for students to receive feedback on their progress, but also to engage learners in active learning. Computer conferencing should include interactive elements that require learners to construct meaning actively within the computer-based environment. Research indicates that higher levels of interaction typically lead to more positive attitudes toward and greater satisfaction with learning (Hackman & Walker, 1990). Interaction in distance education typically occurs between the learner and the content, the learner and the instructor, and the learner with other learners (Moore, 1989). More recently it has been noted that interaction is critical between learners and the technology, particularly with high technology communication devices (Hillman, Willis, & Gunawardena, 1994).

Researchers have reported on the remarkable contributions of computer conferencing to collaborative learning (Davie & Wells, 1991; Harasim et al., 1995; Hiltz, 1994). Collaborative learning and computer conferencing are reciprocally related: while computer conferencing depends on the ability and willingness of participants to collaborate, collaborative learning is enabled by computer conferencing (Cifuentes, Murphy, Segur, & Kodali, in 1998). Romiszowski and Mason (1996) posit that computer-mediated communication provides for two opposing paradigms: instructional, or traditional education, and conversational, which occurs in collaborative learning environments. This conversational style is evident in "learning environments that are more authentic, situated, interactive, project-oriented, interdisciplinary, learner-centered" (Berge, 1997, p. 13).

Overview

In a semester-long university course, graduate students at Texas A&M University used FC software from their own sites or a university computer lab to communicate with each other and with the instructor as an adjunct to the weekly class sessions held by two-way interactive videoconference. Specifically, the students in this interactive, project-oriented course used the asynchronous communication features of the text-based FC system to turn in assignments, moderate conferences, participate in other's conferences, conduct collaborative writing projects, attach files, and conduct real-time discussions through the synchronous chat mode. The students accessed FC from centrally located computer laboratories on the university's main campus, from their own locations via modem with a PPP or SLIP connection, or from other locations with a direct connection to the Internet. With the exception of two occasions on which technical problems prevented access to the server from outside of the local area, students had ongoing access to FC.

The instructor set up the conferences on the FC desktop throughout the semester. Individual icons on the desktop represented the 19 first-level, asynchronous conferences. By the end of the semester, six of the conferences contained between two and eight sub-conferences each. In only one conference was there an additional level of sub-conferences (see Figure 1 for a scanned image of the FC desktop). Although the FC desktop doesn't reflect real-time chats, the students used live chats with the entire class on the three occasions that they did not meet via interactive videoconference. Additionally, as they became more familiar with the chat mode during the semester, students and instructor alike chatted on informal bases with one or two others at a time.



Bernard Asiu 1K Time change to FirstClass Clo 10/29/96 8:24 AM
Karen Murphy 1K FirstClass in Library 10/11/96 3:14 PM
Karen Murphy 1K Upcoming chat 10/2/96 9:18 AM

Figure 1: FirstClass Desktop

Objective

Patterns of communication and the process of constructing meaning in formal education can be profoundly affected by computer conferencing, particularly in university courses in which students do not meet face-to-face on a regular basis. To determine the patterns of communication in computer conferencing, we asked the following questions: 1) What are similarities and differences in interaction and collaboration between computer conferencing and face-to-face learning environments? 2) How does the medium of exchange in computer conferencing encourage or discourage online discussion? 3) What collaborative learning strategies are used in CC? 4) What is the instructor's role in the computer conferencing environment?

Methods

The research team consisted of the instructor and two graduate students, one from the course that was studied and another from a similar course during the same semester. The three researchers collaborated near the end of the semester in the process of data collection, analysis, writing, and rewriting.

Subjects

The subjects of the study were the nine registered students and the instructor of the class. The students had wide-ranging initial expertise and interest in telecommunications in a range from little to no experience with e-mail prior to the beginning of the semester to telecommunication professionals who work in the field. Adding to the complexity of communication were two students whose second language was English.

The pre-course surveys revealed that more than half of the nine students reported having minimal or no experience at all with distance education prior to the beginning of the semester. The majority of the six doctoral and three master's students indicated that they preferred to take the class via distance technologies and felt that the course would hold their attention. The students generally anticipated that they would take more responsibility for

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learning in this class than in a more traditional classroom and that they would achieve as much in this course as in a course taught by more traditional means. They each expected that active communication and interaction with the instructor and their classmates to be as good as it would be in a traditional class. Each expected that the course would help them learn to communicate easily with students in other locations. Several of the students identified their primary reason for enrolling in this elective course as gaining experience in distance learning technologies and resources.

Data Collection and Analysis

At the end of the semester, we downloaded and printed the electronic file of messages from all of the asynchronous conferences and the logs of the live chats. The data sources included transcripts of all computer conferences, real-time (synchronous) chats, and students' electronic journals about computer conferencing; results of pre-course surveys and post-course computer conferencing attitude surveys; and notes from semi-structured interviews with participants.

By using the constant comparative method (Bogdan & Biklen, 1992), we discovered from the student data and emergent categories during the analysis process that we needed to modify our research questions. This method is not a step-by-step process. Instead, it is a dynamic process involving all actions: collecting data; looking for key issues, which become categories of focus; looking for data that provide many incidents of the categories of focus; writing about the categories being explored; and attempting to describe and account for all incidents in data while continually searching for new incidents.

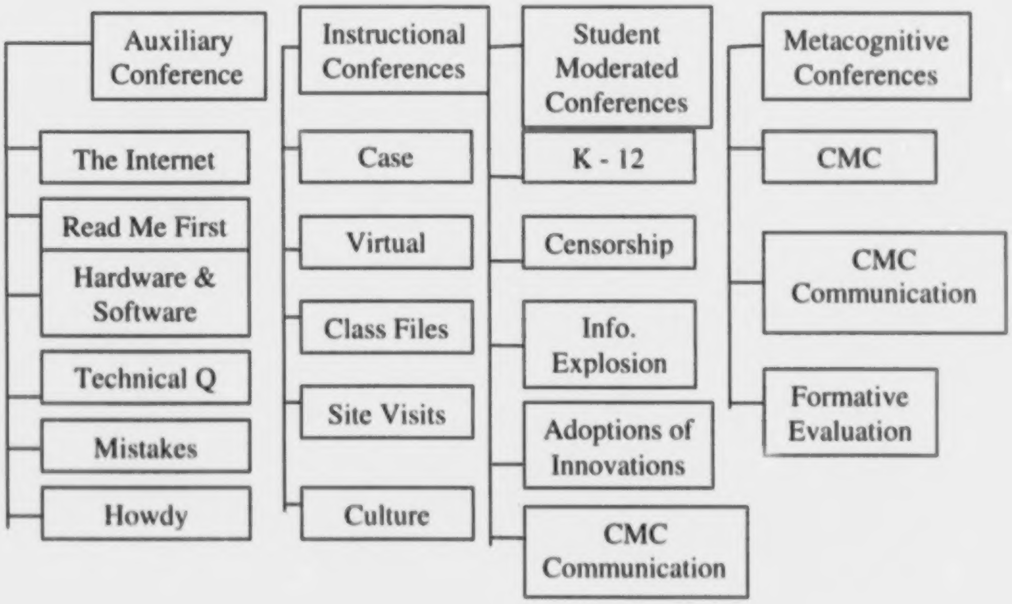
In this study, prior to data analysis, we reviewed the literature for similar studies and to understand data categories identified by previous research. We coded and categorized the data from the transcripts by having one researcher go through the data and evaluate each message based upon the type of information or communication contained in the transcript. The two other researchers then reviewed, discussed, and revised the coded categories as a measure of coding reliability. For example, while individually reading the transcripts, we highlighted and assigned code words to identify the types of interactions or communications that we thought were taking place. Examples are "response to peers," "strokes" (verbal affirmations), and "modeling by experience sharing." We then looked at the codes to determine natural categories. Most of the code words occurred many times in the data; in addition, some of the codes collapsed into larger categories.

We established the following codes to identify quoted messages, which are written precisely as the authors wrote them in the conferences. The author of the message is "I" for Instructor and "S1" - "S9" for the nine students. The four types of conferences that emerged from the data were: auxiliary (outside of the curriculum of the class), instructional (led by the instructor), student-moderated, and metacognitive (shared student reflections). Of the four types of conferences, one was originally student-moderated and later became metacognitive. We identified the conferences by initials; thus, CMC Communication (student-moderated) was "CC-S," while CMC Communication (metacognitive) was "CC-M." The date of each message was also included. For example, a message that Student 5 wrote in the student-moderated section of CMC Communication on October 10, 1996 would be identified with this description following the direct quotation from the transcript: [S5, CC-S, 10/10/96]. The emergent categories that were identified in each type of conference are listed in Table 1 below. Three of the four instructional conferences had several sub-conferences, and in two of the conferences were sub-conferences arranged for small groups to discuss issues and post their paced assignments for each other. Figure 2 is a flow chart of the four types of conferences and the specific conferences that fell into each type.

Table 1: The Code Words Found in Each Type of Conference

Student Moderated Conferences	Instructional Conferences	Auxiliary Conferences	Metacognitive Conferences
Discussion questions	Instructions	Instructions	Perceptions
Response to peer	Strokes	Resource sharing	Instructional strategies
Modeling by experience sharing	Instructional questions	Technical feedback	Impact
Waving	Response to instruction	Technical questions	Barriers
Peer thank you	Opinions	Response to peer	Communication strategies
Closure	Project update	Peer thank you	Response to instructor
Opinion	Response to peer	Information sharing	
Experience sharing	Resource sharing		
Response to moderator	Peer thank you		
Technical feedback	Technical feedback		

Figure 2: Flow Chart of the Types of Asynchronous Computer Conferences


Auxiliary Conference
The Internet
Read Me First
Hardware & Software
Technical Q
Mistakes
Howdy
Instructional Conferences
Case
Virtual
Class Files
Site Visits
Culture
Student Moderated Conferences
K - 12
Censorship
Info. Explosion
Adoptions of Innovations
CMC Communication
Metacognitive Conferences
CMC
CMC Communication
Formative Evaluation

Findings

Following are the findings related to the research questions. A summary of the types of messages in each of the four conference categories is reported in Figures 3, 4, and 5. These three figures identify the types of interaction and communication that took place among the participants. Figure 3 reports student-moderated conferences. The instructor took a minor role in these student-moderated conferences. The largest number of interactions in this conference type was the 51 opinion messages posted by students. The next highest level of interactions in this category was student responses to peers. In Figure 4, instructional conferences are listed. These conferences were instructor-led and in large part had no moderator. The largest number of postings in these conferences was the 43 student "Response to Instruction" messages. The second most frequent message category was student "Opinions."

Figure 5 lists auxiliary conferences, which were conferences established for interactions that were outside of the curriculum of the course. Examples are "Howdy" for students to get acquainted with each other and other technical and administrative topics. The largest number of interactions in this category was student "Resource Sharing" with 21 messages. The second most frequent postings were "Response to Peer" which were students giving feedback to each other.

Figure 3. Student Moderated Computer Conferences
(K - 12, Censorship, Information Explosion, Adoptions of Innovations, CMC Communications)

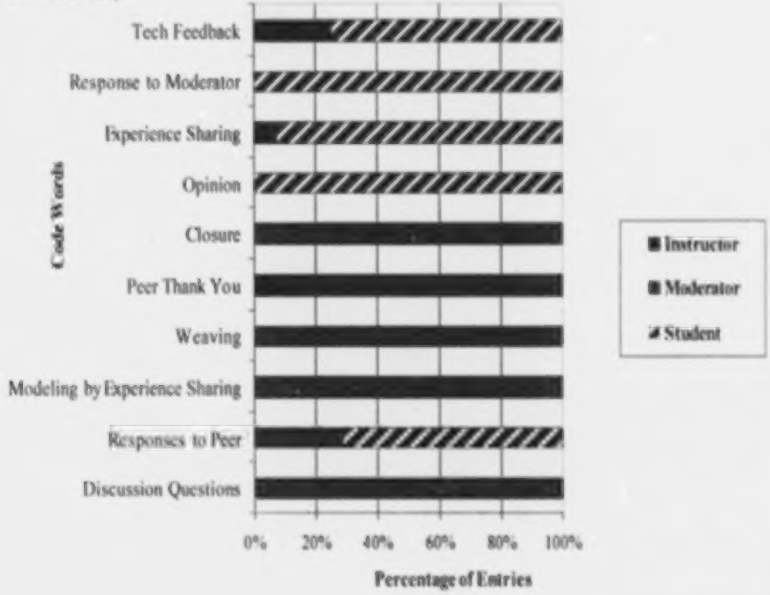
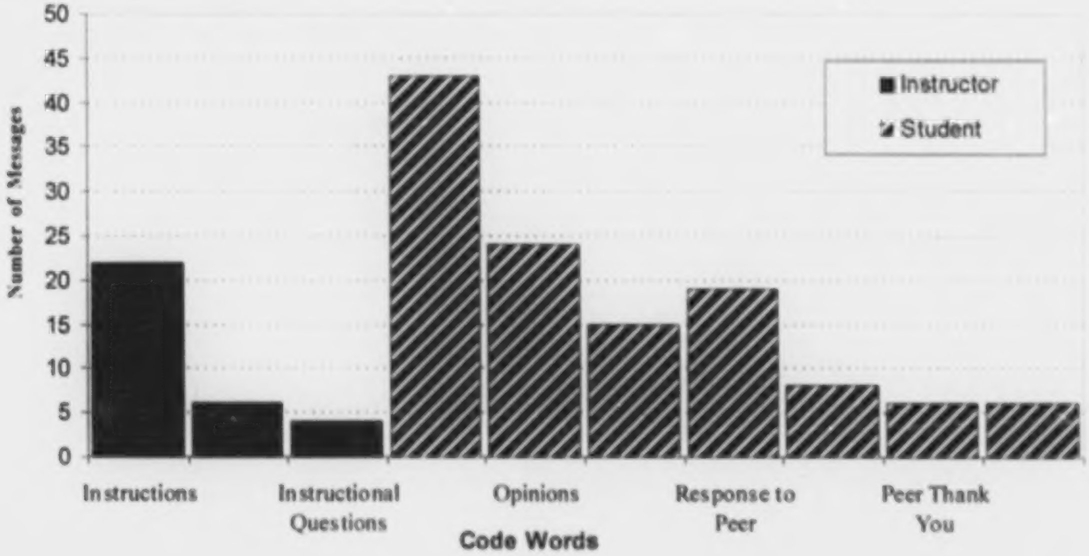


Figure 4: Instructional Conferences
(Case Studies, Virtual Meetings, Class Files, Site Visits, Culture)



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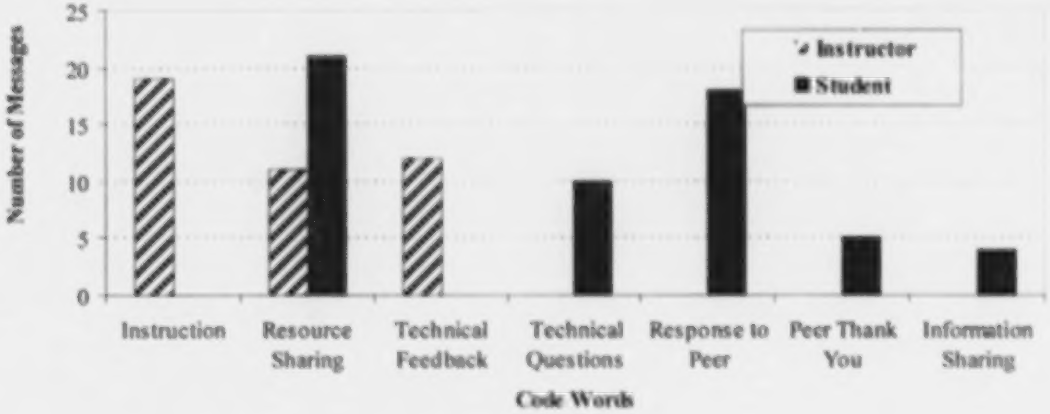
Because the metacognitive conferences consisted of individual reflection rather than reactions to others, Figure 6 summarizes these conferences in terms of the types of reflections that the participants posted. After setting up the conferences, posting forms (like the formative evaluation form), and requesting feedback, the instructor played an insignificant role in these conferences and is therefore not included in the figure. The most frequent type of interaction in this conference type was student reflections on "Instructional Strategies."

Figure 5. Auxiliary Computer Conferences
(Read Me First, The Internet, Hardware& Software, Technical ! & A, Mistakes, Howdy)



In addition to supplying a quantitative report in Figures 3, 4, 5, and 6 on the ways in which computer conference participants interacted and communicated with each other, we address the research questions in a more qualitative manner. We do so by looking at each of the questions in turn and providing evidence through verbatim statements made by the participants themselves in conference. Abbreviations, spelling, and punctuation are printed here just as in the students' original contributions. The issues discussed are related to comparisons of communication and interaction patterns, encouraging online discussion, collaborative learning, and the role of the instructor and obstacles to successful computer conferencing.

Communication and Interaction Patterns

Online interactions share many characteristics with face-to-face education: input of ideas, class discussions, debates, and other forms of knowledge building through interaction and exchange (Harasim, 1990). We identified a number of barriers and benefits of communication and interaction in computer conferencing.

The barriers to computer conferencing were dramatic. Students experienced an initial constraint as a result of having to type all comments, a process that "requires an adjustment to a new form of communication (i.e., using keyboard to communicate with short statements, learning to pause for feedback, etc.)" [S1, CJ, 12/6/96]. They quickly discovered that the steep learning curve was greater for students whose first language is not English and for those with poor typing skills. All of the students found managing large amounts of information and communication to be a challenge.

This reliance on text-based communication provided several benefits, however, which in most cases were benefits that the students learned through the process of computer conferencing. For example, students learned to verbalize their thoughts textually using the delay in the asynchronous discourse to reflect upon the content and the issue of time:

> Although computer-mediated conferencing and email are instant delivery media, the human part - thinking it over and responding still takes time. It some cases it can take longer when responding to email or a conference electronically than doing it in person. We tend to be careful of what we put down if it is saved and displayable for others to see. [S6, FE, 10/2/96]

Because the immediate response time found in face-to-face environments did not exist, they adapted their textual communications to become more descriptive, detailed, and reflective. Students compared their own behaviors in computer conferencing with those in face-to-face environments, recognizing that in the computer conferencing environment "off-task" behaviors are more obvious,

> I remember making some of those off task comments during the chat. When you think about it those side comments are the equivalent to speaking out in class interrupting another conversation with a totally out of place comment... However there seems to the ability to ignore some of this because you can always see what the people on-task are saying and document what the off-task people are doing :) [S2, CJ, 11/23/96].

Such comparisons of communication and interaction in computer conferencing and face-to-face instructional environments indicate that when encouraged to do so, students become aware of communication patterns that take place in their conferences and even become critical of their own behaviors

Encouragement of Online Discussion

The medium of exchange in computer conferencing tends to encourage discussion by allowing participants to learn at their own pace and reflect before replying to a message. Live chats were observed to help draw out students who were traditionally quiet in the face-to-face classroom environment. Once students overcame obstacles like inadequate access to hardware and software, technical problems, and discomfort with new telecommunications software, they remarked that computer conferencing allowed them to have discussions that fostered learning, and they suggested strategies for moderating effective conferences and online chats. Barriers to online discussion included the fact that the speed of typing is slower than verbal interaction, and that threads of the discussion can become confusing if not actively managed. The advantages of this form of communication included: students had more time to read, reflect, write, and revise their ideas; traditionally quiet students tended to increase expression and communication; students were provided with an immediately relevant mechanism for sharing strategies for effective conferencing; and the communication of the formal classroom meetings was enhanced by augmenting discussions and exchange of ideas.

Collaborative Learning Strategies

Researchers suggest that the very nature of computer conferencing—its capacity to support interaction between and among students and teachers—fosters a collaborative approach to learning. Collaborative learning refers to "any activity in which two or more people work together to create meaning, explore a topic, or improve skills" (Harasim et al., 1995, p. 30). In an educational environment, collaborative learning "means that both teachers and learners are active participants in the learning process; knowledge is not something that is 'delivered' to students, but rather something that emerges from active dialogue among those who seek to understand and apply concepts and techniques" (Hiltz, 1994, p. 23).

Barriers to collaborative learning included differences in team member contributions and variability in access to computer equipment. As adult learners, each of the graduate students balanced outside work, family, and schedules that impacted their timing and frequency of participation. The advantage of using computer conferencing with these adult learners is that they were able to participate in collaborative learning projects at the time and place most convenient for them. Some students accessed FC from remote locations and some used equipment located on the campus. Remote students generally experienced greater barriers to access to computer equipment than did on-site students.

Advantages to computer conferencing are that it supports instruction by allowing for communication outside of class time, and it fosters collaborative learning by providing time and place independent communication vehicles for instructor and students. Students commented that the collaborative structure of the conferences helped them advance academically and made them feel part of a larger group. An example of one collaborative learning strategy concerned the student's discussion of the problems and frustrations related to managing the many sources of information including email, voice mail, paper mail, beepers, and other electronic sources of messages and interruptions. Students shared intellectual, practical, and emotional strategies for dealing with information overload in our modern technological environment. While weaving a conference, a student moderator wrote that his classmates had contributed a number of good ideas and strategies for dealing with the volume of information coming from today's technologies.

Instructor's Role in Computer Conferencing

The instructor's role in a computer conferencing environment tends to be different from face-to-face instructional settings. Through CC, an instructor may provide guidance or communication to students privately, without drawing attention to the action as in a face-to-face classroom by taking students aside or asking them to stay after class. An instructor may also more equitably post equal-access announcements to students outside of the classroom environment through email distribution to the enrolled students. Students recognized that prompt feedback on assignments is an advantage of online class conferences. Additionally, advance planning and a clear structure help the students concentrate on the content of real-time chats.

The instructor's role in a computer conferencing environment is different from face-to-face instructional settings (Gunawardena, 1992). In computer conferencing, the instructor must spend significantly more time on a more frequent basis responding to the constant evolution of the online processes (Weiss & Morrison, 1998). One student remarked in the discussion section of an instructional conference that prompt feedback on assignments is an advantage of online class conferences:

For those of us at distant sites, sending in hard-copy papers and waiting for them to be mailed back in the "traditional mode" is often a process that takes weeks - in the meantime additional assignments are done without feedback from the first. By putting our work in FirstClass, we have the benefit of feedback before any more assignments are due - and using all recycled electrons! [S9, SV-D, 9/16/96]. Similarly, advance planning and a clear structure help the students concentrate on the content of their conferences. One student remarked in the final entry of his reflective journal (which the students kept in FC throughout the semester):

> Dr. M's arrangement for group and individual time, with specific instructions on how each is to be carried out, really helps to keep the computer conferencing focused and moving forward while encouraging everyone to participate. [S1, CJ, 12/6/96].

Those who have incorporated computer conferencing into university courses recognize that an immense amount of advance planning, structure, and provision for training on hardware and software are necessary for the communication and interaction to be beneficial to learners (Gunawardena, 1992; McIsaac & Ralston, 1996; Murphy, Cathcart, & Kodali, 1997). This study found that in addition to giving prompt feedback, providing advance planning and clear structure, and planning for hardware and software training, the instructor must play a variety of roles including those of facilitator, coach, guide, expert resource, and arbitrator.

Conclusions and Relevance to the Field

Computer conferencing is an information tool, a communication tool, and a generative tool that fosters creativity and problem solving (Jonassen, 1996). It offers an effective and efficient means of providing information, generating ideas, and communicating to the users. Easy-to-use software features allow the user to concentrate on the content rather than the mechanics of the computer conferencing environment. Computer conferencing supports active, self-directed learning using a structure that is easily modified to fit the different needs of learners and the instructor. Sharing ideas, discussing experiences, and clarifying concepts in the synchronous and asynchronous computer conferencing environment promotes interaction among the students and the instructor. These interactions encourage discussion and reflection, provide accessibility at any time, and stimulate critical thinking, application, and synthesis.

Current periodicals, listservs, and scholarly research have focused increased attention upon the use of computer conferencing to enhance learning (cf., Yakimovicz & Murphy, 1995). Computer conferencing is an important educational tool because of its effect on learning processes, changing rules of communication, and impact on how students enhance their knowledge. If knowledge is defined as the capacity for effective action, computer conferencing is a rich learning environment for student enhancement of knowledge through action.

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STEPS: An EPSS Tool for Instructional Planning

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Introduction

Support for Teachers Enhancing Performance in Schools (STEPS) is a World Wide Web and CD-ROM EPSS designed for PreK-12 and preservice educators to assist in designing and developing lessons, units, or curricula. This "just-in-time" tool was designed around school reform and accountability initiatives in the state of Florida. School districts are required to align existing district-level standards to Florida's new Sunshine State Standards (which is Florida's response to Goals 2000). Educators are required to implement the Sunshine State Standards in all subject areas. Districts will be held accountable for student outcomes related to the Sunshine State Standards through a new test, the Florida Comprehensive Achievement Test (FCAT) beginning in 1999.

To educate both preservice and inservice educators on the new Sunshine State Standards, massive staff development is required across the state. Rather than conducting exhausting hours of inservice training where hundreds attend, receives a notebook, and promptly returns to the classroom to continue with business as usual, it was concluded that a virtual approach to training and continuous support would be more effective and reach the critical mass of educators in a shorter time frame. With the goal of training teachers on Florida's Sunshine State Standards, it became apparent that an electronic performance support system (EPSS) could serve as an innovative approach to staff development and ongoing support. The anticipated outcomes include day-one performance of instructional planning using the Sunshine State Standards; ongoing support through scaffolding instructional tutorials and guidance within STEPS; and for idea sharing among educators across the state with all outcomes geared around the four primary areas of accountability.

Areas of Accountability

Instructional planning is geared around four areas of accountability common in restructuring efforts: (1) integrated curriculum; (2) integrating technology; (3) alternative assessment; and (4) diverse learning environments. For educators to weave the four areas of accountability into the instructional planning process, it was critical that teachers understand more clearly what each area means within the individual classroom setting as well as in the larger school and district-level environment.

Integrated curriculum is defined differently by elementary; middle and high school teachers. Elementary teachers view integrated curriculum as a common strategy for instructional delivery. Elementary teachers typically plan for thematic units across curriculum areas and teach the same kids throughout the day. Middle and high school teachers have a more difficult time adjusting to this approach simply due to the "departmental" structure within the school environment. The mathematics teacher teaches mathematics and in the past has not considered how to weave other subject areas into his or her classroom. Nor has it been contemplated how to team teach with teachers of other subject areas. The complications continue when trying to plan for the team approach when teachers do not have common planning time or when teachers do not serve the same students.

Integrating technology is a restructuring effort that most teachers agree should be accomplished; however, pitfalls arise when software and hardware are not available; when teachers are not trained; and when teachers do not have the time required to learn new technologies (U.S. Congress, 1986). With all of the barriers that exist, many teachers do not achieve true technology integration within the classroom environment for several years. It may never be achieved without district and building-level administrator support (Northrup & Little, 1986).

Alternative assessment is used very loosely within the school environment without much consideration to instructional alignment of objectives, content, and assessment strategy. Using various integrated curriculum models such as problem-based or project-based learning further complicate an educators understanding of how to assess. Many teachers consider the data collection strategy such as using a portfolio the solution to alternative assessment. However, many teachers do not further define the data elements that should be included within the portfolio nor the assessment criteria that should be used to judge the quality of the work.

Diverse learning environments can be defined by educators in two general categories: (1) the learning environment and (2) the learner. Within the learning environment, a teacher may choose to use cooperative learning as a grouping strategy or may choose to integrate instructional technology into the classroom. When examining the individual learner, multiple intelligences, learning styles, and diversity are considered. Many veteran teachers intuitively adjust teaching style and strategies based on the composition of learners in the classroom. Preservice teachers do not have the prior knowledge of how students learn to intuitively make decisions regarding the learning environment and the learner. A formal system of analyzing the learner and the environment has not been embedded in teacher planning strategies, nor are many educators aware of the subtle differences among learners and strategies that can be used to meet their needs.

Critical Design Variables

To achieve the four areas of school reform and accountability and to maintain that all teachers would be able to use STEPS for instructional planning and ongoing support, several design variables were established as guiding principles for the development of STEPS. Variables include:

Easy access. STEPS was designed as a World Wide Web and CD-ROM tool. It was a given that all teachers do not have Internet access in the classroom. However, the team decision was *not* to design for the past but for the current-day classroom environment and the future. Most teachers have access to a CD-ROM. By delivering STEPS using both formats, it was determined that most teachers can gain access to STEPS either in the classroom or at home.

User interface. STEPS was designed with the novice Internet and CD-ROM user in mind. The interface is simple; free of extraneous information; and free of unnecessary graphics, animations, and videos. Consideration for download time via the Internet required forethought on message design decisions. STEPS has a button bar extending the entire left column of the screen with text and graphic buttons for user navigation. STEPS provides directions within the program along with a Coach for scaffolded navigational assistance as required by the user. The theme of STEPS varies by grade level cluster and is followed throughout the individual components.

Model for teacher planning. STEPS must be a model for teacher planning geared around the four areas of school reform and accountability. Using the Events of Instruction (Gagne, Briggs, and Wager, 1992) as the guide, teachers were involved in the design of the model for planning. Used within the model, are "teacher words" as opposed to the nine events of instruction as stated throughout our field. The Events of Instruction is the underlying framework with teacher-driven terminology overlaying. We found this to be a significant step to making the tool usable. Additionally, we found that the model for teacher planning would be somewhat different based on the grade level cluster and the integrated curriculum approach (thematic, problem-based, and project-based learning).

Scaffolding for guidance. Given that STEPS is a tool used by teachers in their own environments, it is critical to provide the support that all educators may require. Scaffolding is a logical design strategy. Educators using STEPS may opt for additional information through instructional tutorials or for additional navigational assistance. It is assumed that STEPS will be used for ongoing staff development at that point of need. STEPS is designed for teachers to use over and over again. It is assumed that the scaffolding will become less necessary as teachers gain familiarity with the tool.

Materials within STEPS are teacher developed and tested. All materials within STEPS are designed by practicing educators who know what works in the classroom. Teachers were contracted to work on the project and began development after learning about the Sunshine State Standards and understanding the four primary areas of school reform and accountability. Teachers developed unit plans, best practices, and identified web sites that would work in their classrooms. All materials have been reviewed by a quality assurance team and have been extensively field tested by practicing teachers and preservice teachers.

Plan for continuous evaluation and revision using concurrent design principles. STEPS has been designed using a variety of models including rapid prototyping (Jones, Li, & Merrill, 1992); prototyping (Tripp & Bichelmeyer, 1990); and Layers of Necessity (Tessmer & Wedman, 1990). The concept of concurrent design (Witt & Wager, 1994) and evaluation (Northrup, 1995) have permeated the process. In designing an EPSS, initial goals can be established, however, the user interface is the key to successful utilization and must be tested and revised throughout the development process. Additionally, given that all of the components within STEPS are inputs and outputs of the entire system, continuous evaluation and revision are essential.

Components within STEPS

To determine the components within STEPS, attention was placed on the overarching definition of an EPSS and how the EPSS, STEPS should be structured. Gery (1991) defines an EPSS as an integrated environment that contains a full range of information, software, guidance, advice and assistance, data, images, tools, and assessment and monitoring systems. The key component of Gery's definition is that an EPSS will permit job performance with minimal support and intervention by others. Raybould (1995) further suggests that the outcome of an EPSS is to "enable individuals to achieve required levels of performance in the fastest possible time and with a minimum of support from other people." Sherry and Wilson (1996) suggest that the potential of an EPSS to assist employees in gaining job-related skills are overwhelming. Employee skills are learned by doing, not by being taught. The result is that a relevant structure must be user-defined and the system must be flexible to accommodate for multiple uses of the EPSS system.

The conceptual framework established by Sherry and Wilson that employees learn by doing not by being taught and that the structure be user-designed and flexible served as the basis of STEPS. Recall that the purpose of STEPS is to assist preservice and practicing teachers in planning using Florida's Sunshine State Standards.

Based on the conceptual framework of: (1) flexibility; (2) learning by doing; and (3) a user-designed structure, while maintaining a clear vision of the purpose of STEPS, several component parts within STEPS were established. To guide the user through the instructional planning process, a Lesson Architect was created. The Lesson Architect is what Gery (1991) would label the Infobase. It includes information, tools, and the methodology for instructional planning. The information resources are layered so that users can pursue information in more depth, just-in-time and at the point of need. The support system or resources that interface with the Lesson Architect include: model units; a best practices database; web links to over 400 web sites; links to the Sunshine State Standards and to accountability information; and over 40 instructional tutorials. The user interface includes scaffolding for support and layered information/resources. The final layer of STEPS is an InfoMAP that maps the instructional planning process for educators (see Figure 1 for a Diagram of STEPS). A detailed description of each component follows:

The Lesson Architect

The Lesson Architect is the centerpiece of this EPSS tool. Users of STEPS will be guided to the Lesson Architect to begin the instructional planning process. Each component of the process addresses one of the four areas common in restructuring efforts, requiring users to contemplate how each component will be designed into individual lessons and activities. The theoretical underpinnings of the Lesson Architect are in Gagne's Events of Instruction (1992), the Dick and Carey model (1996), and through various curriculum approaches including webbing and threaded curriculum.

To use the Lesson Architect, users will insert information directly into forms provided on the world wide web page. Embedded within the Lesson Architect is scaffolded help and more in-depth information on each instructional planning element. Users can access the best practices database; the model units; or the web links to gather ideas for planning the unit or lesson. Additionally, instructional tutorials that will provide instruction on over 40 topics are embedded within the Architect. For example, one of the categories within the Architect is to write instructional objectives. A link to a tutorial that instructs users how to write an objective is included. Users can select to link to the tutorial if needed. Additionally, scaffolded help is available through another link that will describe how to enter information into the form or how to copy and paste information from another location on the web or within STEPS. Finally, a scaffolded link back to the InfoMAP will provide a concept map for users to determine where they are in the instructional planning process. When the Lesson Architect is complete, information can be submitted by selecting the submit button, the user can obtain a printout of the completed lesson plan, or can forward it on to the principal, the practicum teacher, or the COE instructor for review through email.

Tutorial Library

The Tutorial Library is a collection of 40 instructional tutorials that are centered around the four primary areas of focus: (1) integrated curriculum; (2) integrated technology; (3) alternative assessment; and (4) diverse learning environments. The purpose of the Tutorial Library is to provide just-in-time support to users who are attempting to plan using the Lesson Architect. For example, if a user wants to integrate email into an instructional lesson, but is unsure how to actually send and receive email messages, a tutorial on email is one click away. Tutorials are designed as 5-10 minute overviews with opportunity for users to investigate further through hypertext links to examples, resources, and more information on the specific topic of interest.

The Model Units

Four model units exist currently on STEPS. One model is designed for each of the four grade level clusters: PK-2; 3-5; 6-8; and 9-12. Each model unit was created by teams of teachers representing the grade level clusters. For grades PK-2, Communities is the theme with a 10-day model unit accompanying. Grades 3-5's unit is on 16th Century Florida History as students go online and search for missing Luna Ships in the Pensacola Bay. Grades 6-8 uses Native Florida Habitats as the theme. Finally, grades 9-12 uses Terrestrial Archaeology is the theme. All units were designed, developed, and implemented by cross-curricular teams of elementary, middle, and high school teachers. Each unit is comprised of 10 days of instruction designed using the Lesson Architect that models integrated curriculum, integrated technology, alternative assessment, and diverse learning environments. The model curriculum units make cross-curricular connections in Math, Science, Social Studies, and Language Arts using benchmarks established in Florida's Sunshine State Standards. Within the model units, there are embedded hypertext links to instructional tutorials, to relevant web sites, and to Florida's Sunshine State Standards. Additionally, video clips modeling various aspects of the unit including diverse settings, the use of technology, and others are available within the 10 day units.

The model units serve as a focal point for the themes within each grade level cluster. The units are designed for teachers to use as models for planning their own units using Florida's Sunshine State Standards. The units link to four online Internet expeditions that will be online beginning late Spring 1998. The expeditions enable teachers to fully integrate instructional technology in the classroom while following exciting expeditions by archaeologists, scientists, and community workers. (see http://www.uwf.edu/~pacee/steps to access the online expeditions).

Related Web Links

Over 400 web sites have been identified as relevant to Math, Science, Social Studies, and Language Arts to parallel Florida's Sunshine State Standards. Web sites are keyed to the Sunshine State Standards and provide a one-paragraph summary of the content addressed on the site. All sites have been evaluated for instructional integrity and can be used as a resource for teacher planning using the Lesson Architect and for classroom instructional use.

Best Practices Database

The Best Practices Database is a sharing success database of ideas that work in the classroom. Classroom teachers from several school districts have contributed to the best practices database by submitting lesson plans, ideas for classroom assessment, technology integration, cooperative learning, and more. Within STEPS, users can access the best practices database either by Sunshine State Standard and subject area or by a keyword search. Either approach will yield significant strategies and tactics that work in the classroom. It is intended that users of STEPS will access the Best Practices Database to gather ideas for instructional planning within the Lesson Architect.

The Coach

The Coach is the STEPS approach for scaffolded help. It is designed on three levels to provide scaffolded support throughout the entire program. Using the Knowledge Integration Environment presently being created by University of California - Berkeley as the model (Bell, Davis, & Linn, 1997), we have established a parallel "Knowledge Integration Coach" that will provide help on: (a) The Big Picture; (b) What Do I Do?; and (c) How Do I Do It? Each level of scaffolded help will serve as prompts and context-sensitive feedback as students work through STEPS.

Overall Benefits of STEPS

STEPS is an EPSS designed to assist preservice and veteran teachers in planning using Florida's Sunshine State Standards. Currently STEPS is being used by teachers throughout the state with great success. Practicing teachers welcome the just-in-time approach to learning how to plan using the Sunshine State Standards. Preservice teachers using STEPS are being prepared to enter the workforce with the most current knowledge, skills, and abilities in school reform and accountability. Both preservice and practicing teachers have a model for planning that includes support and guidance along with literally thousands of resources and ideas for classroom implementation. Teachers continue to report that resources available at their fingertips is the most significant benefit to them.

Though unanticipated in the initial design of STEPS, many other benefits have occurred. Individual school districts are requesting that STEPS be customized to meet individual district needs with lesson planning and with best practices. Additionally, districts view STEPS as an optimal tool for virtual staff development within school and district staff development plans. It has been requested that we incorporate pre and post tests for instructional tutorials and for the Lesson Architect so that individual teachers may receive inservice points for completing components within STEPS.

Both preservice and practicing teachers and school districts are using STEPS in ways not originally anticipated. The conceptual framework of building a model that is flexible has not only gained benefits for the original intent, many view STEPS as an iterative process for continued design and development as a "one-stop shopping" tool for educators.

Conclusion

STEPS is an electronic performance support system currently being used by middle school educators in Florida. It's capability will be expanded to elementary and high school teachers in phase II of our grant, beginning Summer 1997. Additionally, STEPS is being used in Preservice Teacher Preparation courses to prepare teachers to integrate curriculum & technology, conduct alternative assessment, and work in diverse learning environments. The components of STEPS work in tandem to provide just-in-time training and support to teachers through the Lesson Architect and all of the corresponding materials. Finally, scaffolded help is provided to guide and facilitate the teacher through the instructional planning process using a nurturing, supportive approach with video and audio clips as a guide.

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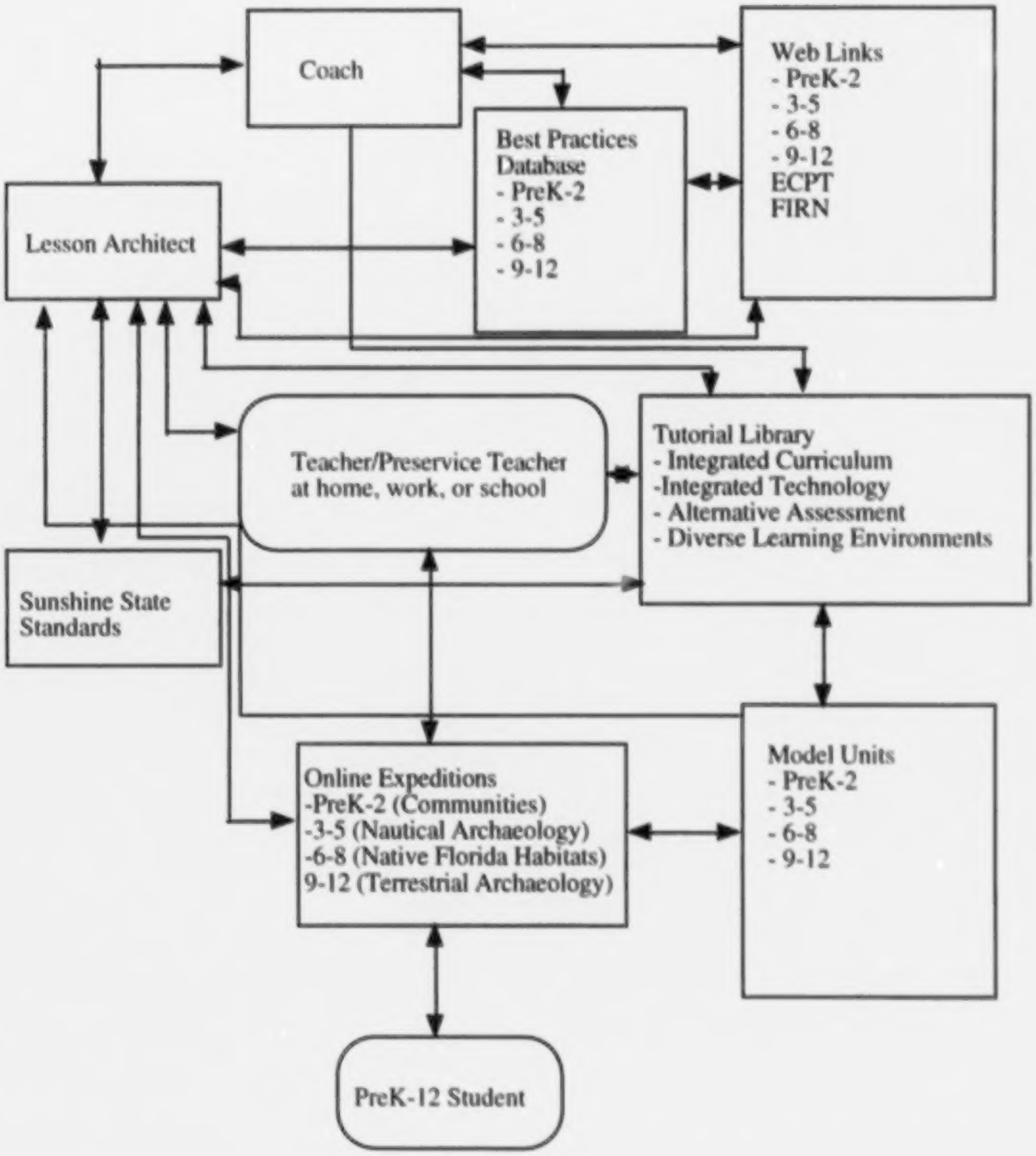
Figure 1: STEPS Diagram


Coach
Web Links
- PreK-2
- 3-5
- 6-8
- 9-12
ECPT
FIRN
Best Practices Database
- PreK-2
- 3-5
- 6-8
- 9-12
Lesson Architect
Teacher/Preservice Teacher at home, work, or school
Tutorial Library
- Integrated Curriculum
-Integrated Technology
- Alternative Assessment
- Diverse Learning Environments
Sunshine State Standards
Online Expeditions
-PreK-2 (Communities)
-3-5 (Nautical Archaeology)
-6-8 (Native Florida Habitats)
9-12 (Terrestrial Archaeology)
Model Units
- PreK-2
- 3-5
- 6-8
- 9-12
PreK-12 Student

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Pre-Service Teacher Preparation and Interactive Information Technologies Critical Mass

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Abstract

This study examined critical mass for the use of information technologies (electronic mail and Web applications) in Schools, Colleges, and Departments of Education (SCDEs) by faculty, students, and faculty and students combined. The study also investigated critical mass for the existence of adequate infrastructure for information technologies. A sample survey design was used to collect data from professional teacher education institutions. The 1996 SCDE Technology Survey was mailed to 744 SCDE institutions. Responses were received from 465 institutions for a response rate of 63%. Achievement of critical mass was based on the number of institutions identified as SCDE faculty and student users (combined), SCDE faculty users, SCDE student users, and SCDE institutions which provide adequate infrastructure for information technologies. Results confirm critical mass has been reached in SCDE use of information technologies and for the provision of adequate infrastructure for the use of information technologies. Recommendations and implications for other issues associated with technology integration are included.

Introduction

The purpose of this research study was to advance the knowledge base in the area of critical mass for the use of and infrastructure for information technologies (e-mail and Web applications) within pre-service teacher education institutions. While the results of this study are not particularly surprising to those who study diffusion and change related to technology, the documentation and dissemination of the results have strong implications for several areas associated with technology integration (e.g., accreditation guidelines, professional teacher standards, school reform, public perception of teacher preparation in and access to technology). This study was developed on the functional definition of critical mass given by Rogers (1995, p. 313): "the point at which enough individuals have adopted an innovation so that the innovation's further rate of adoption becomes self-sustaining." Unfortunately, little contemporary critical mass data exists to aid administrators and practitioners in planning for increased implementation and utilization.

Problem/Significance

During the summer of 1996, a research study of 465 Schools, Colleges, and Departments of Education (SCDEs) was conducted to determine whether critical mass for the use of e-mail and Web technologies had been reached by SCDE faculty, SCDE students, and SCDE institutions (combining data from both independent user groups). Markus (1990, 1987) describes interactive technologies as any which require reciprocal communication; where the spread of their use relies on the users' contributions of information. This study concentrated specifically on electronic mail and Web technologies (Bulletin Board Systems (BBS), computer conferencing, the Internet) as the interactive media. The lack of documentation regarding current use of information technologies and critical mass levels leaves educational institutions without important information necessary to weigh the advantages and disadvantages of continued investments in technologies infrastructure. The availability of information technologies and the documented increase in the number of users of information technologies across general populations indicates that core requirements are in place to achieve critical mass (Geoghegan, 1994; Green 1996b). This study investigated critical mass for information technologies specifically within SCDEs.

Literature Base

Critical mass is a conceptual construct of diffusion theory which has tremendous influence on the practical applications of systemic change models. Many researchers and change theorists (e.g., Rogers, 1983, 1995; Markus, 1990; Van de Ven & Rogers, 1988; Valente, 1993, 1995; Zaltman, Duncan, & Holbeck, 1973) have explored critical mass as an indicator and a predictor of successful adoption efforts within a wide variety of disciplines and settings.

There are increasing pressures on teacher preparation institutions to prepare new teachers to effectively use technology (Ely, 1996). The Office of Technology Assessment (OTA, 1995) continues to call for reforms which upgrade the quality of teacher preparation, with emphasis on increasing the implementation and integration of technology within classrooms. One result has been that colleges and universities are embracing information technologies to address the public pressure for reform in the way teachers deliver instruction (DeLoughry, 1996). While computers and information technologies are commonly used as research tools in higher education settings, Denk, Martin and Sarangarm (1993) have shown that computers and information technologies are not an integral part of classroom instruction.

The work of Kenneth Green (1997, 1996a, 1996b) and colleagues (Green & Gilbert, 1995; Green & Eastman, 1994) has documented critical mass levels for institutions of higher education and access to computer-based technologies. This study focused on documenting critical mass for access *and* use of interactive information technologies within pre-service teacher preparation institutions.

Limitations

The limitations of this study were the sample identification, survey instrument and distribution, and knowledge base of survey respondents. The sample was the membership of an intact national organization consisting of private and public four-year schools, colleges, and departments of education. Using this sample placed a limitation on generalizing to SCDEs which are not members of the intact organization. The potential for a low response return rate with a mailed survey jeopardizes representativeness and generality due to the selective nature of the non-respondents.

The survey instrument was created by the research team. Two recognized experts in the field of change in schools examined the survey for face and content validity. The SCDE Technology Survey was sent to member institutions of the national organization as part of a larger survey and submission was completely voluntary.

The survey respondent's knowledge base was a potential limitation. The larger surveys were completed by an administrator within the member SCDE. One limitation is that the administrator may not have known enough about information technologies to respond accurately. A second is that the administrator may have completed the survey based upon their personal beliefs or perceptions of the SCDE's use of information technologies and not upon actual use of information technologies within the SCDE. Inter-woven in this limitation is that the administrator answered on behalf of SCDE students and faculty based on their knowledge, observation, and perceptions of information technologies use.

Methodology

A well-respected professional teacher education organization commissioned the design and analysis of a survey to gather data about technology use within SCDEs. The one page (front and back) survey was mailed (by the sponsoring organization) to 744 member institutions. These researchers received 465 (63%) useable responses from the United States, Guam, and Puerto Rico. Questionnaires were completed by an administrator in the SCDE. Of the 23 questionnaire items, 15 were used to compile the data for determining critical mass levels. Details of the coding are available if requested (Tharp, 1997). Description and analyses of the additional data collected are available in report form (Persichitte, Tharp, & Caffarella, 1997). The four research questions associated with critical mass were answered by calculating an observed critical mass value for combined SCDE faculty and student use of e-mail and Web technologies, for SCDE faculty use of e-mail and Web technologies, for SCDE student use of e-mail and Web technologies, and for the existence of required infrastructure for the use of e-mail and Web technologies.

Users and nonusers (faculty, student, combined faculty/student) and adequate/inadequate infrastructure were determined by combining data from five questionnaire items for each of the data groupings. If the combined value was greater than or equal to 60%, the institution was coded as a "user" and/or "adequate." The 60% cut-off was chosen to parallel Green's (1996a) research of technology use at two-year and four-year higher education institutions. This coding provided the data for the observed critical mass levels. These observed critical mass values were compared to a pre-determined critical mass level of 16% to conclude whether critical mass had been reached. The decision to compare the observed critical mass value with a critical mass value of 16% was made based on reviewing previous statistical analyses of critical mass conducted by contemporary researchers (Markus, 1987; Valente, 1995; Rogers, 1995).

Results

Results confirm critical mass has been reached in SCDE use of information technologies and for the provision of adequate infrastructure for the use of information technologies. for all the research questions, the observed critical mass values greatly exceeded the statistical critical mass comparison level of 16%.

RQ1: Has critical mass for combined SCDE faculty and student use of e-mail and Web technologies been reached?

The observed critical mass value for this question was 87% (405/465). Critical mass has been reached for combined SCDE faculty and student use of e-mail and Web technologies.

RQ2: Has critical mass for SCDE faculty use of e-mail and Web technologies been reached?

The observed critical mass value for this question was 92% (429/465). Critical mass has been reached for SCDE faculty use of e-mail and Web technologies.

RQ3: Has critical mass for SCDE student use of e-mail and Web technologies been reached?

The observed critical mass value for this question was 90% (420/465). Critical mass has been reached for SCDE student use of e-mail and Web technologies.

RQ4: Has critical mass for the required infrastructure for the use of e-mail and Web technologies in SCDEs been reached?

The observed critical mass value for this question was 95% (444/465). Critical mass has been reached for the required infrastructure for the use of e-mail and Web technologies in SCDEs.

Conclusions

The results of this study document that critical mass has been reached in student use, faculty use, combined faculty and student use, and the provision of adequate infrastructure for e-mail and Web technologies across SCDEs. Results indicate that the SCDE adoption rate (92%) has surpassed the overall higher education adoption rate (59%) cited in Green's research (1996a, 1997). MacKnight (1995) argues that once SCDEs have reached critical mass for information technologies infrastructure, there is an opportunity to progress from being hardware access centers to becoming information centers. The issue which now faces SCDE administrators is no longer whether faculty and students will use the technology, but **how** they will use the technology in the classroom (Awbrey, 1996; Cummings, 1996).

Recommendations

For those SCDEs which have adequate infrastructure in place (or are approaching that goal): create an information technologies plan which focuses on classroom implementation and integration. This study confirms that the number of adopters of information technologies is high enough to ensure continued adoption of the technologies. Continued use, however, should be supported by a three-year life-cycle technology plan, as opposed to the standard five-year strategic planning model, to provide for the update and replacement of obsolete hardware, software, and networking. Another factor likely to influence continued use by existing adopters is the availability of faculty training for the use and integration of these information technologies which continue to change so rapidly. The importance of continual opportunities for faculty at all levels and in all disciplines to engage in updating their personal and pedagogical skills related to technology use cannot be over-emphasized. Finally, for institutions of higher education, continued utilization and implementation of information technologies by faculty may hinge on revised incentive plans which recognize and/or reward faculty for the significant knowledge, time, and initiative required to reach high levels of technology integration within instruction.

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Conditions that Facilitate Teachers' Internet Use in Schools with High Internet Connectivity: Preliminary Findings

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Abstract

Examines the presence of Ely's (1976, 1990) conditions that facilitate innovation, as reported by Internet-using teachers in leading-edge schools. Descriptive data from a national survey of teachers (N=238) in approximately half of the 250 schools in the National School Network (NSN) are reported, along with analysis of the correlation of the condition measures with teacher and student Internet use. Connections are drawn to other NSN-related studies and plans for further analysis of the covariance of the conditions and interaction effects are described.

Background

The history of educational technology is filled with promises of technological innovation being offered as a way to improve teaching and learning. Today we are in the midst of yet another high-stakes, government and industry-sponsored effort to introduce technology to bring about educational change. The federal government, states, and private organizations are spending unprecedented amounts of money for the advancement of Internet use in schools -- offering the hope of more to win, and the risk of more to lose for those who are concerned with educational change and technology.

Many claim that the Internet is a revolutionary technology for learners because of its ability to provide resources, data sharing, and communication to all who are connected (Hunter, 1993, 1995a, 1997a). It is instructive to remember, however, that previous claims for the superiority of new technologies for education have often foundered not on the quality of the technologies themselves, but on complex issues related to implementation in schools (Berman, 1981; Fullan, 1993; Holloway, 1996; McLaughlin, 1990).

The informants for this study are Internet-using teachers in a select group of schools that have already achieved a high level of Internet connectivity.[3] These teachers are perhaps the best informants for what conditions facilitate Internet use by students and teachers, i.e., once a school has already been connected to the Internet. As more schools obtain Internet connectivity the issues addressed in this study may become increasingly important.

By examining teachers who are striving to use the Internet, this paper avoids problems associated with those who have not adopted (Rogers, 1983) or who may be resistant to using these new technologies. Finally, while implementation is often discussed at an organizational level, the variables for study are viewed as teacher-level variables with the *teacher as the unit of analysis*, partly because one might expect different experiences and perceptions reported by teachers in the same school (Becker, 1994a). Thus, this study might be understood as an examination of individual teacher behavior (extent of use) and conditions that may be determinant for those who are among the strongest Internet users.

Framework of Analysis

Research demonstrates that many issues influence the implementation of educational technology innovations. "The more factors supporting implementation, the more change in practice will be accomplished" (Fullan, 1991, p. 67). This study utilizes a reasonably holistic framework developed by Ely (1976, 1990), one of the few frameworks available in the literature (Holloway, 1996). Ely's claim is that lack of any of these eight conditions can hinder use of an innovation:

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[3] The schools are part of the National School Network (NSN) project organized by researchers at BBN in Cambridge, MA in 1994 with funding the National Science Foundation (Contract # RED-9454769).

1) *dissatisfaction* with the status quo
2) existence of *knowledge and skills*
3) availability of *resources*
4) availability of *time*
5) existence of *rewards or incentives*
6) expectation and encouragement of *participation*
7) *commitment* by those who are involved, and
8) evidence of *leadership* (Ely, 1990)

This framework appears to be broadly generalizable, readily applied in diverse educational settings, from school districts (Read, 1994), to libraries (Ely, 1976) to universities (Bauder, 1993), in the United States and abroad (Ely, 1990). A series of dissertation studies also support its usefulness for a variety of educational innovations (Bauder, 1993; Jeffrey, 1993; Read, 1994; Riley, 1995; Stein, 1996). Perhaps more importantly, the utility of this framework is supported by the literature related to computer use in schools, i.e., many of the studies one sees include variables that seem to be consistent with Ely's conditions -- e.g., dissatisfaction (Barker and Taylor, 1993); knowledge and skills (Sheingold, et al., 1981); resources (Becker, 1994b; Office of Educational Technology, 1996); the availability of time (Honey and Henriquez, 1993; Sheingold and Hadley, 1990), and so on.[4]

Methods

This study reports data from a national survey of teachers in approximately 250 schools registered in the National School Network (NSN), a project funded by the National Science Foundation since 1994. The schools were required to have had at least 10 simultaneous LAN-based Internet connections for a year prior to joining the project and to be nominated by an intermediary organization involved in Internet-based school reform (Hunter, 1995b). "Internet-using teachers" include teachers, media-specialists, or other professional staff who do any of the following:

- Have students in their class use the Internet, either in their classroom or elsewhere at school;
- Supervise students of other teachers in Internet use and are at least partly responsible for the activities the students engage in while using the Internet; and/or
- Use the Internet themselves, either at school or at home, for professional purposes.

School-level contacts were mailed a "Teachers Sampling Form" requesting the names of up to 10 of the "strongest Internet-using teachers" in the school.[5] Once these forms were returned (response rate approx. 60%), three teachers in each school were sampled. As in past studies by Becker (1994a), stronger users were over-selected, with probabilities related to their reported extent of use as indicated on the Sampling Form. The assumption here is that the distribution of users has a "long tail" so that only a few users are very strong at each school; a random selection would tend to miss these stronger users.[6] The booklet for the Internet-using teachers had 13 pages containing 54 questions, and approximately 60% were returned -- after data cleaning this resulted in a total sample size of 238 teachers from 124 different schools for this analysis.

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[4] Other topics from the literature, such as psychological variables (Marcinkiewicz, 1993; Marcinkiewicz and Regstad, 1996), and leadership *styles* (Hall and Hord, 1987) are not included in the current analysis.

[5] Henry "Hank" Becker at University of California, Irvine, co-authored and supervised the study. Network coordinators, technical coordinators, administrators and teachers not listed among the top ten Internet users were also surveyed. Copies of instruments, descriptive data, and reports are being made available online: http://nsn.bbn.com/
nsn_learnings/survey.html.

[6] Along these lines, data cleaning removed approximately 30 teachers who failed to indicate use with students on a series of screening questions. A sample of "other" teachers suggests that approximately one-third of teachers not identified as among the top Intertnet users in their school would have met the minimum requirements for inclusion in this study had they completed the Internet-Using teachers survey.

Internet Use

This study explores a wide range of Internet uses by teachers and students (Eisenberg and Ely, 1993; Harris, 1994; Honey and Henriquez, 1996). This includes constructivist practices identified in leading-edge schools, e.g., activities highlighted in conferences and newsletters shared across the National School Network project (Hunter, 1997b) such as project-based learning activities (email projects, telementoring, shared investigations, students publishing on the Web, collaborating with other school sites, and participating in live events over the Internet).

While some uses of an innovation may be more sophisticated (Hall and Loucks, 1977) or exemplary (Becker, 1994a) than others, implementation studies using Ely's framework have typically not differentiated between types or quality of use. It is understood that teachers will use the Internet differently. This study employs frequency-based measures (e.g., number of hours, how often), and measures of the breadth of use (e.g., number of students, number of activities) so that those who involve more students and and who participate in a wider range of activities score higher on use.[7]

To identify the extent of Internet use by teachers, this study combines information from seven sets of questions in the teacher survey booklet (comprising approximately 25 different response items):

- MAXUSE: The maximum use a teacher made of the Internet in his/her classes, on a scale from 1 to 4, where 1 represented no use; 2, voluntary student use; 3, occasional use by all students; and 4, use by all students on at least five occasions.
- AVGUSE: The average use a teacher made of the Internet across all his/her classes.
- REQDUSE: The frequency with which the teacher *requires* students to use the Internet.
- NNETPROJ: The number of discrete types of network learning activities the teacher has had students participate in during the year (from a list of 17 types including working with scientists, tutoring students by e-mail, doing Web searches, etc.).
- USE4PREP: How frequently the teacher accesses the Internet while doing class preparation work during the school day.
- SELFUSE: How frequently the teacher engages in six other Internet-related activities, such as posting a message to a newsgroup, or creating or editing a World Wide Web page for their class or school.
- FUNCTION: How many of five functions for using the Internet (e.g., professional collegiality—sharing new ideas, discussing teaching) occupies the teacher for at least an hour per week.

While this study is generally more concerned with an overall use measure, factor analysis seems to confirm that two related factors can be identified. A "student use" factor is based on scores on the first three items listed above. These concern the extent of student classroom use. The last three items listed above load on a different factor called "teacher use". Interestingly, the variety of activities undertaken with students (NNETPROJ) loads with the "teacher use" items, suggesting that the variety of activities undertaken with students is more closely related to a teacher's own exploration or use. As a result, the "teacher use" factor may be interpreted more as reflecting exploratory use by the teacher.[8]

Approximately 75% of the teachers reported that all the students in at least one of their classes had used the Internet, with approximately 20% indicating that they require student use of the Internet on a weekly basis. Of the variety of networking activities listed, by far the most frequently reported uses with students were looking at World Wide Web sites and searching for information online (both reported by over 90% of teachers). The next most common activities for students, creating Web sites or participating in email exchanges, were only reported by about 30% of teachers.

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[7] Efforts to obtain a framework for determining "level of use" (Hall and Loucks, 1977) for Internet implementation were not successful prior to development of this study. Partly because the Internet is a relatively new innovation, any use by teachers is considered noteworthy. Becker (1997) begins to examine the impact of Internet use on specific teaching practices, such as having students work on longer projects.

[8] The overall use measure includes all the items (standardized reliability alpha = .81). It is calculated from the sum of the two orthogonal factors ("student" and "teacher" use) which is equivalent (r=1.00) to a single factor solution. Oblique factor analysis reveals the extent to which these factors are, in fact, related to each other (r=.53). Unless indicated otherwise, relationships to "overall" use and oblique factor scores are reported, i.e., not controlling for the other factor. If only overall use is reported, no striking differences were observed between student and teacher use.

Concerning their own use, most teachers (approx. 70%) reported spending at least an hour per week developing their Internet skills or searching the Web for instructional materials. Only one-third reported spending more than one hour per week using the Internet for professional collegiality. About half reported having *ever* posted to newsgroups/listservs or having ever created a Web page. Fewer than 20% reported that they had ever participated in real-time events via the Internet, such as text-based chats or videoconferencing. Additional descriptive analysis of use by students and teachers within NSN schools is provided by Becker (1997) and Hunter (1998).

Operationalizing Conditions

The conditions are understood to be "global" constructs that are made up of a variety of components. The approach has been to try to "write or select items presumed to be tapping each of the facets" (Pedhazur and Schmelkin, p. 68). Given the scope of the project, no exhaustive measurement of each condition is possible; instead a few indicators are intended to suggest the extent to which each condition might be present. In a few cases exploratory factor analysis seems to confirm that different elements of a condition are being measured.

Organization of the variables by condition is based on an interpretation of Ely's framework. For example, items related to peer use (Becker, 1994a) are interpreted as belonging to the commitment condition, an indication of support for Internet use by others, while administrator use is viewed as an indicator of leadership.[9] While formative use of the instrument generally focused on whether key issues for teachers were being addressed by the conditions items, perhaps more attention might have been paid to the subjects' view of the framework itself.[10]

Findings

Findings describe the extent to which the conditions seem to be present, and the strength of relationship between the conditions and Internet use measures. Correlations are discussed in terms of the ability to predict the extent of use from knowledge of the conditions measures; this suggests that a relationship exists, but not necessarily a causal one (the findings could just have easily been discussed in terms of predicting the presence of conditions from scores on use). These are preliminary findings because no effort has yet been made to control for the presence of other conditions, to explore the covariance (multi-colinearity) of the conditions, or to examine interactions that might be more predictive of use. Addtional analysis might also seek to control for intervening variables, such as grades and subjects taught, class ability level, or school-wide demographics.[11]

Condition #1: Dissatisfaction with the status quo

Dissatisfaction indicators include the perception that all students would benefit from Internet use, both in general and in terms of learning outcomes. In addition, dissatisfaction with the status quo (in this case, non-Internet use) is indicated by the extent to which the teacher affirms a number of reasons for Internet use, choosing from a list of 13 options (Table 1).

Respondents overwhelmingly agreed that all students would benefit from knowing how to use the Internet, with 80% indicating that they strongly agree. Concerning whether students would enjoy learning more leading to greater effort and accomplishment, the response was more mixed, although still generally positive (Figure 1). Responses on the two items were correlated ($r=.28$), and the mean response was significantly correlated with overall use ($r=.37$).[12]

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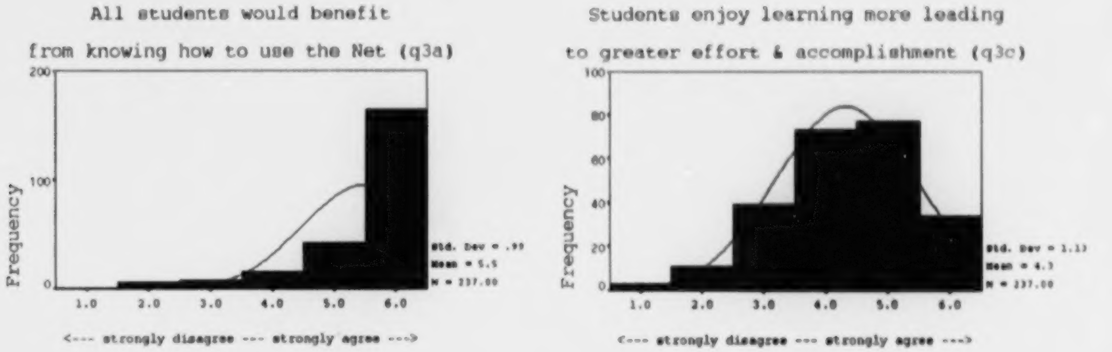
[9] The next stage of analysis may examine the empirical validity of distinctions such as these.

[10] Formative use included completion of the survey by a dozen (12) teachers in seven (7) Syracuse-area schools accompanied by open-ended interviews, site visits, and an unpublished district-level case study.

[11] Becker and Ravitz (1997) found that higher ability classes may be favored with Internet use, particularly in schools with larger traditionally disadvantaged populations, and that subject and grade-level differences may exist as well.

[12] Unless indicated otherwise, all correlations reported in this paper are $p < .001$, two-tailed.

Figure 1. Perception that students would benefit from Internet use



The difference reflected in the above responses may reflect alternative rationales for use (Hawkridge, et al., 1990) such that benefits other than pedagogical ones are perceived. This interpretation is supported by analysis of the reasons given for use. The most prevalent reason among the teachers seemed to concern the pervasiveness of technology in society, a rationale that may not necessarily require learning outcomes.[13]

The distribution of mean responses for the reasons items (reliability alpha =.83) approximated a normal curve and had about the same correlation with overall use (r=.35) as the mean "benefits" score. In the end, an average z-score on both sets of items (reliability alpha = .84) was an even stronger predictor (r=.44) of overall use.

Table 1. Reasons for Internet use ordered by mean response[14]

Q-31 Which of these are reasons for your own use of the Internet at school? How important a reason is it for you?	Mean	Med	Md	S.d.
e) to prepare students for life in an increasingly technological society	2.69	3	3	.57
g) to keep up with new technologies yourself to gain access	2.47	3	3	.72
l) to resources or materials that are not available in textbooks or in the library	2.43	3	3	.76
a) to increase student motivation and participation in their own learning	2.39	3	3	.82
b) to provide opportunities for students who do not have computers at home	2.37	3	3	.86
d) to give students the skills they will need in college	2.22	2	3	.87
f) to help students feel more a part of the global community	2.22	2	3	.93
h) to find out about new teaching practices that you may want to use or adapt	1.93	2	2	.90
j) to reduce your professional isolation through e-mail or collaboration with others	1.49	2	2	1.10
m) to support larger school change efforts by using the Internet as a catalyst	1.49	2	2	1.10
c) to fulfill students' and parents' expectations	1.43	1	1	1.02
*i) to overcome remoteness or geographic isolation in your school or community	1.27	1	0	1.19
*k) to overcome a lack of specialized staff or limited program offerings at your school	.89	1	0	1.01

Key: "Not a Reason"/"NA" = 0; "Very important reason" = 3

*Note. Rural and poor schools are somewhat underrepresented in NSN (Becker and Ravitz, 1997).

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[13] Hawkridge's fourth ratonale -- developing workplace-related skills -- was not asked here, however Goldman and Laserna (1996) found this to be an important rationale within the NSN schools they studied. Exploratory factor analysis suggests that reasons related to the pervasiveness of technology in society (items c, d, e, f, g) were related to both student and teacher use. However, reasons related to use of Internet as a catalyst for school improvement (items h, i, j, k, m) only correlated with teacher use (r=.35), while reasons related to other student benefits, only loosely interpreted as a pedagogical rationale (items a, b, i) were associated more with student use (r=.25).

[14] Data in all tables reflect four (4) or fewer missing cases (98% completion) unless indicated otherwise. Measures of central tendency and standard deviations are based on the scoring key shown within or below each table.

Condition #2: Knowledge and skills

Knowledge and skills indicators include self-reported skill levels with respect to 13 different Internet activities. In addition, teachers were asked to what extent they were sufficiently prepared to use the Internet with respect to five skills that may be required for classroom use. The most prevalent of the "Internet skills" included using a search engine and sending email (Table 2); the most prevalent of the "classroom skills" involved finding relevant online information and awareness of what the Internet can do (Table 3).

The mean for all items (reliability alpha=.93) was the best predictor of "teacher use" (r=.70) and was strongly correlated with overall use (r=.54). However, factor analysis created a single factor that combined the "classroom skills" items with two from the "Internet skills" list --- searching the Internet and downloading materials. This factor might still be interpreted as "classroom skills" because the additional items represent among the most frequent kinds of use with students (Becker, 1997). This factor alone was the best predictor of student use (r=.32), an equally strong predictor of overall use, and a reasonably strong predictor of teacher use (r=.48). The two other factors -- one involving Web authoring and IRC/MOO, and the second involving "other" skills (email, ftp) -- might be viewed as more "technical" in nature; these correlated with teacher use, but were not predictive of use with students.

Table 2. Self-reported "Internet skills" for 13 activities ordered by mean response

Q-40 How would you rate your ability to do each of the following things related to the Internet?	Mean	Med	Md	S.d.
c) Use a search-engine like Alta Vista to find information you need	2.52	3	3	.86
b) Send e-mail to groups of people without naming each person each time	2.25	3	3	1.01
a) Send attached files with an e-mail message	2.11	2	3	1.05
i) Download and read file saved in a specific format (e.g., Word, Adobe Acrobat)	1.79	2	3	1.17
e) Subscribe to a Listserv and participate in discussions with others	1.47	1	3	1.19
d) Find a Usenet newsgroup and discuss topics of interest on it	1.40	1	1	1.08
f) Put files on a server for others to access	1.32	1	0	1.19
j) Produce a simple Web page (e.g., containing text and graphics)	1.30	1	0	1.24
h) Translate graphics into a format for placing on the Web	1.10	1	0	1.21
k) Produce a complex Web page (e.g., tables, frames, sounds, animation)	.76	0	0	.98
l) Be a Web Master for a school or district (e.g., design and manage Web sites)	.61	0	0	.95
g) Participate in discussions on IRC, MOO, or MUD	.45	0	0	.79
m) Do programming for Web pages (e.g., CGI, PERL, JAVA, Shockwave)	.42	0	0	.80

Key: "None" = 0; "Low" = 1; "Medium" = 2; "High" = 3; "Don't Know" = 0

Table 3. Self-reported "classroom skills" related to Internet use ordered by mean

Q-41 To what extent are you sufficiently prepared to use the Internet? *Do you have sufficient...*	Mean	Med	Md	S.d.
b) Ability to seek and find relevant online information	2.40	3	3	.70
a) Awareness of what the Internet can do	2.37	2	3	.72
d) Knowledge of how to use the Internet in the curriculum	2.03	2	2	.79
e) Classroom management skills related to Internet use	2.00	2	2	.86
c) Ability to manage large amounts of electronic information	1.93	2	2	.92

Key: "Seriously lacking" = 0; "Somewhat lacking" = 1; "Generally present" = 2; "Very present" = 3

Condition #3: Resources

Two sets of resource indicators include support resources -- technical, training and curriculum support -- and hardware resources (e.g., computers and connectivity). Of the support resources, teachers generally reported that technical support and training opportunities were sufficiently present (Table 4). However, resources for Internet use in the curriculum and help for integrating online activities into the curriculum were most often reported as being insufficiently present. The mean score on these four items (reliability alpha = .80), was correlated with overall use (r=.17, p<.01), but the mean of the two curriculum-related items (correlated, r=.58) was a stronger predictor (r=.22).

Table 4. Resource-related conditions reported as being sufficiently present ordered by mean

Q-35 To what extent are the following conditions sufficiently present to support Internet use by you and your students? Sufficiently present...	Mean	Med	Mode	S.d.
e) Technical support is available when you need it	4.05	4	5	1.56
k) Training opportunities are offered to develop your Internet skills	3.84	4	5	1.62
f) Curriculum resources for Internet use are available	3.41	3	2	1.49
l) Help is available for integrating online activities into the curriculum (e.g., workshops or meetings to help teachers plan activities)	3.10	3	2	1.54

Key: "Strongly disagree" = 1; "Strongly agree" = 6. (9-12 missing cases, includes "Don't Know"/"DK" responses)

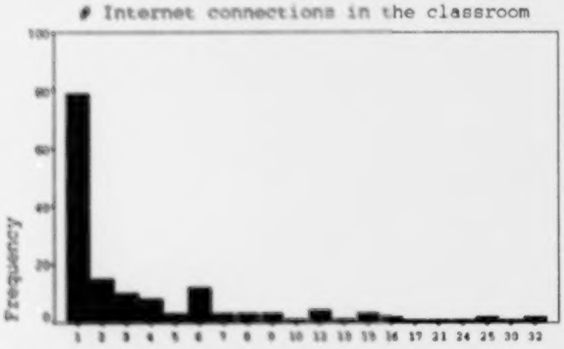
Concerning hardware resources, teachers were asked whether or not better Internet access in the future would increase their use (Table 5). A majority indicated that classroom Internet access and simultaneous access for 20-30 computers would increase their use "a lot". Surprisingly, those who scored higher on use were more likely to report that improved access would help "a lot" -- this suggests that less frequent users may not perceive access as being a critical issue, while more frequent users might take greater advantage of improved access if it were provided. As a result, an indicator score from these items (reliability alpha = .87) was not at all predictive of use (r= -.03).

Table 5. Access-related resources would increase use ordered by percent indicating "a lot"

Q-1 Which of the following features of the Internet or conditions for accessing it would make you likely to use the Internet more?	% "A lot"	% "A little"	% "Not at all"/"NA"
a) Internet access in your own classroom rather than elsewhere in your school	61	5	34
c) Simultaneous Internet access for 20-30 computers in a computer lab	57	14	29
d) Access to the World Wide Web	55	6	39
b) High-speed Internet connection rather than modems	52	11	37
e) Electronic mail to/from anyone in the world with an Internet e-mail address	44	14	42

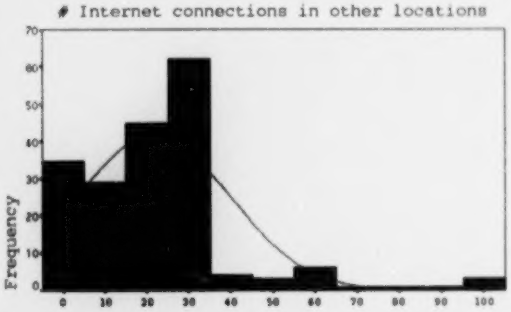
Next, teachers were asked to indicate the number of simultaneous Internet connections in the location where students most frequently use the Internet -- inside the classroom, outside the classroom, or both. 60% indicated that the classroom is a location where students most often use the Internet, and 80% indicated that students most often use the Internet in another location -- with 45% providing data on both locations. The highest number of simultaneous connections reported in the classroom was 32, but a full half reported only one Internet-connected computer (Figure 2). The mean response for the number of simultaneous connections in a location outside the classroom was 21, however some reported up to 100 (Figure 3); these latter cases indicated that they were reporting for multiple locations (e.g., "in other classrooms" or "labs").

Figure 2. Number of simultaneous Internet connections in the classroom (if classroom is a location where students most often use the Internet)



Mean = 4.4; Med = 1; S.d.= 6.2 (n=142, 60%)

Figure 3. Number of simultaneous Internet connections in other locations (if students most often use the Internet outside the classroom)



Mean = 21.6; Med = 20; S.d.= 17.97 (n=190, 80%)
Note: midpoints shown, first bar represents < 5

The number of simultaneous Internet connections *in the classroom* was correlated with overall Internet use (r=.26), predictive of use by teachers *and* students. When limiting the analysis to those who answered 50 or fewer (n=178), the number of simultaneous Internet connections *outside of the classroom* was only significantly correlated with *student* Internet use (r=.28), particularly when controlling for teacher use (r=.39). Because more than half of the teachers did not answer one of these items, a more useful indicator is the maximum z-score on the two items (the two z-scores were correlated, r=.29) -- i.e., whether or not a teacher reports a larger number of connections than other teachers in *either* location. This indicator was also predictive of overall use (r=.22).

Finally, teachers were asked about the amount of RAM memory on the computer they use most frequently at school. A little over 10% reported having 32MB or more. About half reported having 16MB; one-quarter reported 8MB, and fewer than 15% reported any less than that. When the amount of RAM was converted to an interval (as opposed to ratio) variable, it was moderately correlated with overall use (r=.19, p <.10).

Condition #4: Time

When asked whether there is sufficient time to support Internet use -- in the teacher's work schedule and in the curriculum -- there was strong disagreement on both items (Figure 4). The response concerning time in the curriculum was a better predictor of Internet use, even though teachers were more likely to disagree that there was sufficient time in the schedule. Time in the schedule was correlated with overall use (r=.21), but not as strongly as time in the curriculum (r=.35). The two items were correlated (r=.55), and the mean response was also predictive of overall use (r=.32).

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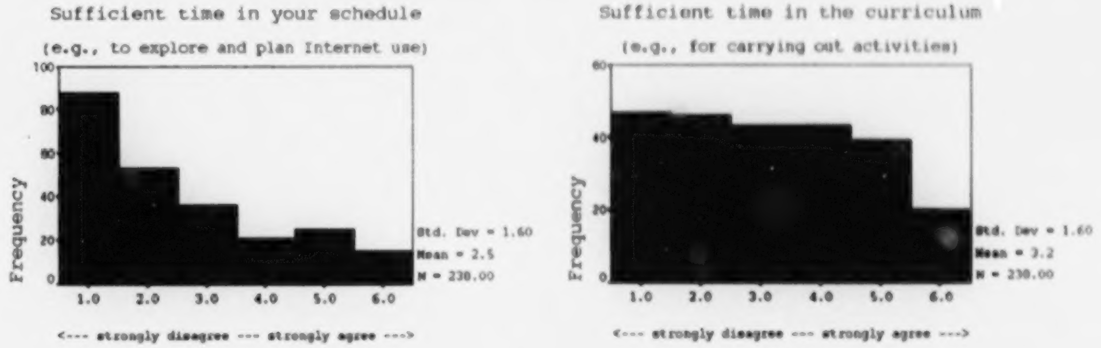
Figure 4. Insufficient time available for teacher Internet planning and use in the curriculum



Teachers were also asked to report the actual amount of in-school preparation time they are given each week as part of their work schedule. Approximately 20% reported 1 hour or less per week. The most frequent response was 5 hours, with an average of about 4 hours. This included a few teachers who reported more preparation time, i.e., a cluster of about 10% who reported 6 or more hours/week, even up to 10 hours.

The amount of reported preparation time was, surprisingly, not correlated with the above items related to the perception of time availability, nor did the amount of actual preparation time correlate with any of the Internet use measures. A possible explanation is that teachers do not necessarily have access to the Internet during their in-school preparation time. This might be an example of a resource variable "access" interacting with a time variable "preparation time", a relationship that might be explored further. Although not a time variable per se, those who reported using the Internet more frequently during their class preparation time (USE4PREP) also scored significantly higher on student use ($r=.33$) even when teacher use was held constant ($r=.11$, $p<.10$).

Condition #5: Rewards & Incentives

Rewards and incentives indicators include two sets of items -- the first involves the perceived level of benefit for students with whom the teacher has used the Internet. While this variable may be more a result of use, not a cause, students benefiting is viewed as an important intrinsic motivation for continued, ongoing use, i.e., after some initial attempts have been made. The intention was to have some indication of a perceived reward concerning the teacher's relationship with students (Mitchell, et al., 1987). This item is different from the more hypothetical dissatisfaction measure concerning whether all students would benefit.

Teachers reported that most of their students had benefited greatly from their use of the Internet (Table 6). Approximately 15% of the teachers reported that *all* of the students with whom they had used the Internet had benefited greatly; nearly all (92%) reported that more than half had benefited at least "somewhat". Finally, negative experiences were rarely reported, most (62%) indciated that *none* of their students had a negative experience overall. The percent of students reported as having "greatly benefited" was significantly correlated with overall use ($r=.38$).

Table 6. Mean percent of students reported as having benefited at each levels

Q-25 Of your students who have used the Internet, estimate the percent of them in each category:

Negative experience overall	Benefited very little	Somewhat benefited	Greatly benefited
3.3	10.2	29.7	56.7

The primary educational value that was reported involved access to a huge variety of curriculum information. Approximately half of the teachers reported that students were applying themselves for longer periods of time, taking more responsibility for their own learning and showing greater interest in world events and foreign cultures as a result of Internet use. About half also reported a more equal distribution of expertise among students and that average students were communicating at 'gifted' levels. Fewer (less than 1/3) indicated benefits in terms of

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students having a deeper understanding of the ideas the encounter, and having experiences with or increased interest in the adult world.[15]

The second set of indicators concern the availability of various "extrinsic" rewards or incentives that might be provided to teachers by the school or district (Table 7). Of the items listed, those that were reported as being generally available involved the provision of computers, equipment or modems to teachers who are interested in the Internet. In addition, release time, reimbursement for inservice courses, and public recognition were reported in about half (40-50%) of the cases. For the remaining items a majority indicated that the reward or incentive was "not available".

The mean response for each teacher on all these "extrinsic" items (reliability alpha =.70) was correlated with overall use (r=.22). For those items that showed a relationship with use (a, c, d, f, g and h), the mean score was only slightly more predictive of use (r=.25).[16] There seemed to be no relationship between the percent of students having greatly benefited and the availability of extrinsic rewards or incentives.

Table 7. Extrinsic rewards or incentives "somewhat" or "generally" available ordered by sample mean

Q-50 To what extent are each of the following rewards and incentives available at your school to encourage teachers' use of the Internet?	Mean	Med	Md	S.d	% available "at all"
a) Teachers who show they are interested are provided with computers/equipment	2.08	2	3	.82	80
b) Computers or modems are loaned to teachers for use at home	1.79	2	1	.77	58
e) Cost of in-service/graduate credits for Internet workshops/courses is reimbursed	1.69	1	1	.78	50
c) Release time (substitutes) are provided for Internet development activities	1.53	1	1	.67	44
f) Public recognition given for leadership, helping other teachers/staff use Internet	1.53	1	1	.69	42
d) Paid time provided for after school hours spent on Internet-related activities	1.33	1	1	.59	26
h) District/school has contests rewarding innovative technology-using teachers	1.19	1	1	.50	14
g) Career-ladder opportunities for telecommunications-using teachers	1.17	1	1	.42	16

Key: "Not available" = 1; "Somewhat available" = 2; "Generally available" = 3. (13 missing cases)

Condition #6: Participation

Participation indicators include the extent of a teacher's involvement in setting the course for Internet implementation in their school or district -- contact with decision makers concerning Internet-related issues and the extent of involvement in various other activities supporting implementation. Concerning direct involvement in decision making, respondents were most likely to report having a trusted colleague to whom they can voice their concerns. While they generally reported having an opportunity to voice concerns, fewer reported having their input directly sought by decision makers, e.g., before decisions are made (Table 8).

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[15] Network coordinator data actually show a decrease in some of these benefits being reported since 1995, including students having greater interest in world events and foreign cultures, a deeper understanding of ideas they encounter, and greater interest in the adult world (Becker, 1997).

[16] Of course, selecting only those items that "work" as predictors of use may capitalize on chance; the utility of these particular items as opposed to others would have to be confirmed in follow-up studies.

Table 8. Extent to which teacher input is sought by decision makers ordered by sample mean

Q-32 To what extent is your input sought by decision makers in your school or district concerning Internet-related issues?	Mean	Med	S.d.	% never (=1)	% sometimes (=2)	% often (=3)	% always (=4)
b) There's a trusted colleague to whom I can voice concerns	3.18	3	.89	5	16	34	45
a) I have opportunity to voice concerns to decision makers	2.72	3	.86	6	37	37	20
d) I am given updates and asked for feedback	2.51	2	.85	11	40	37	12
c) My opinions are sought before decisions are made	2.28	2	.86	17	47	26	10

Note. Percent of valid responses shown, rounded. Key included in table. (9-12 missing)

Of the various other types of activities in which a teacher might participate, those reported most frequently included selection of hardware and software, providing support to other teachers, and working on curriculum integration (Table 9). Regarding other activities, half or more reported that they were not involved "at all".

Table 9. Teacher involvement in various other activities ordered by mean response

Q-36 To what extent have you been involved in any of the following activities?	Mean	Med	S.d.	% Not at all (= 1)	% Slightly (= 2)	% Generally (= 3)	% Very (= 4)
a) Reviewing, selecting, purchasing hardware/software products	2.67	3	1.08	18	27	26	29
b) Providing services to other teachers, training /tech support	2.65	3	1.16	23	22	22	33
f) Developing ways of integrating Internet into the curriculum	2.32	2	1.10	31	25	25	19
e) Serving on Internet-planning committee, school or district	2.06	2	1.20	48	19	12	21
c) Developing products for others, e.g., software or guidelines	1.97	2	1.07	47	22	20	12
d) Developing school or district-wide policies for Internet use	1.93	1	1.11	50	21	15	14
h) Meeting with parents/community members re: Internet use	1.52	1	.81	65	21	11	3
g) Attending school board meetings to discuss Internet issues	1.36	1	.73	76	15	6	3

Note. Percent of valid responses shown. May not total to 100% due to rounding. Key included in table.

In addition, teachers were asked if regular meetings to discuss Internet issues were sufficiently present. Most (75%) respondents tended to disagree that Internet-related meetings were sufficiently present, many (36%) disagreed strongly; this was among the least sufficiently present of the items reported by Ravitz (1997). While this may indicate a desire for more involvement in decision-making, the wording of the question was not specific enough to determine this, i.e., responses could also indicate a desire to have others types of Internet-related meetings, e.g., with peers regarding curriculum uses.

Overall, teachers who use the Internet more were more likely to participate in decision making and planning activities. A combined *z*-score using the items from all three questions (reliability alpha =.88) correlated with overall use (r=.35). Dropping the last item, which provided less value in terms of predicting overall use (r=.17, p<.01), the mean score on the two sets of items was more predictive of teacher use (r=.52) and overall use (r=.42), than it was of student use (r=.24); in general, this condition seems to be more closely associated with teacher use.

Condition #7: Commitment

Indicators of commitment include the extent to which there is sufficient organizational-level commitment for Internet use and to which various stakeholder groups have been supportive of Internet use over the past two years. Additional indicators include the number of other teachers in the school with whom the teacher regularly converses about the Internet, and the number of others who are estimated to be using the Internet. Finally, teachers were asked about the overall supportiveness of people in different stakeholder groups.

The "organizational-level" commitment indicators (Table 10) were reported as being generally present, this included the existence of a long range plan, a substantial budget being in place or assured, and Internet use as a priority in school improvement plans. Approximately 70% tended to agree that each was sufficiently present, with most respondents agreeing strongly. Responses to these three items were correlated with each other (r >.56) and the mean response on all three was predictive of overall use (r=.23). The perception that Internet use is a priority was more closely associated with increased use (r=.24), while the existence of a substantial budget was a slightly less powerful predictor, although still statistically significant (r=.16, p<.02).

Table 10. Commitment items concerning planning for Internet use are present

Q-35 To what extent are the following conditions sufficiently present to support Internet use by you and your students?	Mean	Med	Md	S.d.
a) A long range plan for Internet development and use is in place	4.26	5	6	1.55
b) A substantial budget has already been approved, or is assured	4.05	4	6	1.60
c) Internet use is a priority in existing school improvement plans	4.36	5	6	1.49

Key: "Strongly disagree" = 1; "Strongly agree" = 6. (9-12 missing values)

Concerning the supportiveness of various stakeholder groups (Table 11), responses generally indicated support for Internet use from each of the listed groups. Vendor or corporate sponsorship (item h) was the only of these items that had a significant correlation with overall use on its own (r=.22, p<.02). The mean of all these items (reliability alpha = .86) was also predictive of overall use (r=.17, p<.02).

Table 11. Level of reported support by groups of stakeholders

Q-33 Over the past two years, how supportive have people in the following positions been in promoting the school's Internet use?	Mean	Med	Md	S.d.	Missing
b) Teachers (e.g., on committees, talking to others, demonstrating uses)	3.28	3	3	.69	5
c) District-wide committee or task-force (e.g., district-level planning)	3.21	3	4	.85	20
f) District technical support (e.g., install/maintain computers/ networks)	3.21	3	4	.94	15
e) District administration (e.g., policies, hiring people, seeking grants)	3.10	3	3	.88	25
d) School board or decision making body (e.g., budgets, dev. policies)	2.98	3	3	.90	20
a) Parents (e.g., asking for Internet, bond issues, attending meetings)	2.91	3	3	.92	28
i) District or school curriculum supervisors (e.g., ideas/materials for use)	2.73	3	3	1.0	23
g) Local community members (e.g., voting funds, interest, activities)	2.52	3	3	.90	54
h) Vendors or corporate sponsors (e.g., hardware, software, telecom corps)	2.45	2	2	.95	51
j) Local businesses (e.g., partnerships, instructional/technical support, interest)	2.18	2	2	.90	65

Key: "Unsupportive" = 1; "Strongly Supportive" = 4. "Don't Know" responses treated as missing.

Concerning the number of other teachers in the school with whom a teacher has discussed the Internet in the past month, most (80%) reported speaking with 10 or fewer teachers, however approximately 10% reported speaking with over 25 in the last month. This was a relatively strong predictor of overall use (r=.37), especially after a square-root transformation created a more normal distribution and one positive outlier was removed (r=.46). Finally, the estimated proportion of other teachers at the school perceived to be Internet users (Table 12) was also significantly correlated with overall use (r=.27).

Table 12. Estimated proportion of teachers and administrators who use the Internet

Q-42 Approximately how many of the teachers and administrators at your school do you think use the Internet? Cirle one...

	Teachers (Q-42a)	Administrators (Q-42b)
"A few"	24%	35%
"About half"	39%	17%
"Most"	19%	17%
"Nearly all"	14%	21%
"Don't Know"	2%	9%
	Mean=2.2; Med=2, S.d.=1.0; Missing=8	Mean=2.3; Med=2; S.d.=1.2; Missing=23

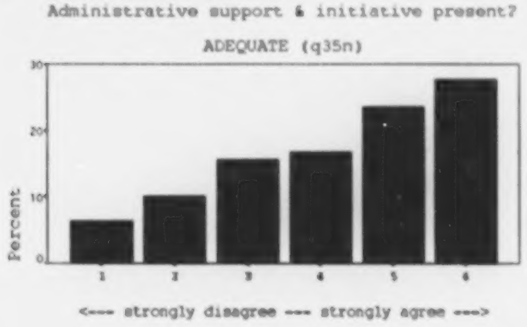
Key: "A few" = 1; "About half" = 2; "Most" = 3; "Nearly All" = 4; "Don't know" = Missing.

Condition #8: Leadership

The last condition involves the extent to which administrators and school principals are seen as advancing use of the Internet. This includes the estimated number of administrators who use the Internet themselves, the perception that administrative support is sufficiently present, and the overall stance taken by administrators with respect to Internet use. An additional form of leadership that was explored concerned a teacher's awareness of other individuals who may have made extraordinary efforts to bring about school Internet use.

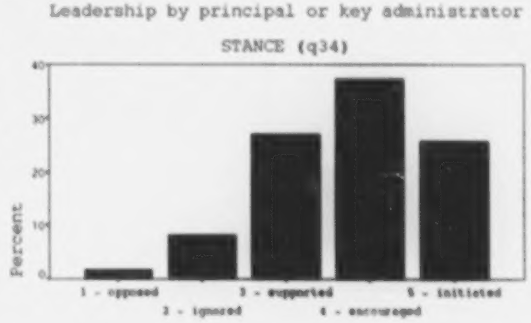
The estimated proportion of administrators who are Internet users (Table 11, above) was moderately correlated with overall use (r=.15, p<.05). Generally, administrative support for Internet use was reported as being "sufficiently present" (Figure 6); responses on this item correlated with *overall use* (r=.14, p<.05). Concerning the overall leadership stance, approximately 90% indicated that the principal or key administrators had at least been generally supportive (Figure 7); however, this was not a useful predictor. The mean z-score on these last two items was predictive of *teacher use* (r=.14, p<.05), but not student use -- the perception of administrative support seems to be more closely associated with teacher use than student use, possibly because of additional conditions required to support use with students. Still, the mean z-score on all three items, including the proportion of administrators using the Internet (reliability alpha =.68) was predictive of *overall* use (r=.15, p<.02).

Figure 6. Administrative support is sufficiently present to support Internet use?



Mean 4.2; Med= 5; S.d.=1.56 Missing= 4

Figure 7. Leadership stance taken by principal or key administrator



Mean= 3.8; Med=4; S.d.=.98 Missing=9

Concerning others in the community making extraordinary efforts to bring about Internet use (Table 13), the most frequently mentioned types of individuals tended to be those who work in the school (principal, technology coordinator/media specialist, teachers) or a district-level specialist. None of the other types of individuals were mentioned in more than 10% of the cases. Incidentally, of those who wrote in "other" responses (n=15), three respondents chose to highlight extraordinary efforts made by the school board or a school board member.

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Based on a comparison of means (ANOVA), those teachers who reported extraordinary efforts by a university liaison were significantly more likely to score higher on use measures.[17] Other important leadership roles, by this criterion, included that provided by a principal or school administrator, and that provided by vendors of network software, educational content or computers.

Table 13. Extraordinary efforts by individuals in various groups and relationship to Internet use ordered by reported frequency

Q-51 Is there someone who has made extraordinary efforts to bring to reality a vision of tele-communications use in your school--someone who has made a substantial contribution that would not have been made by other individuals in that same role? *Circle as many as apply, but be "tough."*	#	%	Mean diff. in overall use
b) School computer or technology coordinator or media specialist	60	25	.02
c) A teacher	54	23	.09
d) District-level technology specialist or other district administrator	40	17	.15
a) Principal or other school administrator	31	13	.37**
e) Specific parent(s)	8	3	.07
h) University faculty member or students or network-based project liaison	8	3	.81***
i) A provider of network software, educational content or computer retailer	7	3	.47*
f) Local business person, corporate sponsor or professional person in your community	7	3	-.12
g) Government official	0	0	.00

*$p < .20$ **$p < .06$ ***$p < .02$

Interestingly, those who reported extraordinary efforts by a local business person or community member scored slightly lower on overall use, however this was not a statistically significant finding. The total number of items selected was moderately predictive of use ($r=.12$, $p<.05$), while the number of the three significant items that were indicated was a somewhat better predictor ($r=.19$, $p<.005$). Of these three items, 60% of all respondents ($n=141$) reported none, 35% ($n=82$) indicated at least one, and only 5% ($n=12$) responded that individuals in two of these roles had made extraordinary efforts -- all but one indicated the principal or school administrator, paired seven times with a provider, and four times with a university liaison.

The number of people reported as making extraordinary efforts was correlated with the mean *z*-score on the other leadership items. The mean *z*-score on all four leadership indicators (reliability alpha=.63) was a better predictor of overall use ($r=.20$, $p<.005$) than any single leadership indicator.

Summary

For each of Ely's conditions (1976, 1990) several survey items were developed based on a review of the literature. Descriptive data reported here suggest which conditions seem to be most present or lacking as reported by Internet-using teachers in leading-edge schools. For example, it seems that technical and training resources, administrative support and organizational commitment are among the most present; conditions that seem to be lacking include time for planning and curriculum use and the availability of curriculum-related help and resources.

In general, indicators for each condition are significantly correlated with use measures, including both teacher and student use. Within each condition certain indicators are stronger predictors than others. Some that appear to be more predictive of ***student use*** include classroom-related knowledge and skills, and curriculum resources; those that seem more predictive of ***teacher use*** include more "technical" Internet knowledge and skills, the extent of participation in decision making and other implementation-related activities, and the perception of support for Internet use by principals and administrators. The conditions that seem to be most predictive of use overall, based on measures developed here, include knowledge and skills and dissatisfaction with the status quo. In addition, a few individual indicators from other conditions seem to be strong predictors -- the number of other teachers in the school with whom a teacher discusses the Internet, and the number of students reported as having benefited greatly.

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[17] Goldman and Laserna (1996) provide case studies of NSN schools involved in university-school partnerships.

The next stage of analysis will focus on the covariance of indicators across the conditions, possible interaction effects, and exploration of new factors that may cut across the framework --- such as all the items related to curriculum integration. A regression model will determine the extent to which the conditions as a whole can account for differences in the extent of teacher Internet use. In conclusion, the framework may help shed light on the complex interplay of conditions, all of which seem to be related to teacher implementation of the Internet, the latest in a long line of educational technology innovations.

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Foundations for Creating Effective Two-Way Audio/Video Distance Education Environments

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Abstract

The promise for the successful use of distance technology is great. However, distance education is laden with the potential for student anxiety, brought on by the technology, that could hinder the effectiveness of instruction in such an environment. This study seeks to determine the relationship between students' perceptions of the two-way audio/video classroom and their anxiety. Additionally, it seeks to determine the relationship between students' perceptions of the two-way audio/video classroom and their satisfaction with their distance learning experience.

222 students in two-way audio/video distance classes completed inventories that measured their: anxiety in the distance situation, satisfaction with learning in the distance learning environment, and perception of key elements in the two-way audio/video learning environment. The data collected for each measure (anxiety, satisfaction, and key elements in the environment) was then correlated and step-wise regression analyses were run. The findings indicate that there is a positive relationship between student anxiety in the distance situation, their satisfaction with learning in the distance learning environment and their perception of key elements in the two-way audio/video learning environment. In addition, key elements of the environment explain a significant portion of the variance of student anxiety in the two-way audio/video environment. These environmental elements also explain a significant portion of the variance of student satisfaction with the learning experience.

In the past decade we have seen a technological explosion. This in turn has increased the growth and development of distance education programs. However, an unfortunate side effect of this rapid change is that much of the population has been left behind. As a result, people from all walks of life experience techno, or computer, phobia (Rosen & Maguire, 1990; Mahmood & Medewitz, 1989). Our study extends the ideas of earlier authors to an environment that was created as a result of this technological explosion: two-way audio/video distance education classes. In particular, this study explores the environment in a two-way audio/video classroom, its relationship to students' anxiety, and ultimately how it might affect interactivity and satisfaction with the learning experience.

Issues regarding interactivity, anxiety and satisfaction and the quality of learning experiences are not new. Educators have long realized the importance of interaction among students and instructors in facilitating the learning experience. However, in a two-way audio/video distance education environment these issues take on an even greater importance. Researchers have repeatedly stressed the importance of real-time interaction among people in a distance education environment (Barker, Frisbie, & Patrick, 1989; Wagner, 1994). Furthermore, distance education researchers have stressed the importance of student-instructor interaction in order to decrease anxiety and increase motivation (McIsacc & Gunawardena, 1996; Ehrman, 1990). In an extensive review of the literature, McIsaac and Gunawardena (1996) noted that nearly one-fourth of the literature was on this topic. Obviously, interaction is an integral part of a distance education class. Numerous methods can be applied to foster interaction, but one area that should not be ignored is student comfort. Student comfort, or the absence of anxiety, is essential in promoting interaction in a classroom.

One cause for concern regarding student anxiety in a distance education environment is that the physical distance between classrooms, the students, and the teachers can strip the class participants of the physical presence

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and comfort that can be found in a traditional classroom (Moore & Kearsley, 1996; Bruce & Shade, 1995). Two-way audio/video was originally seen as a solution for problems associated with the dispersion of members of the classroom. In essence, two-way audio/video was intended to promote the presence normally found in a face-to-face situation. In turn, this technology was also intended to foster better interaction, thus creating a better and more satisfying learning experience for the students. To a certain extent, two-way audio/video has met these expectations (McIsacc & Gunawardena, 1996).

These findings are supported by communications research. Researchers in this area have found, when examining interactions between people over two-way audio/video versus face-to-face situations, that people tend to communicate equally well in either situation. With respect to communication, there were little differences between the two mediums (Sellen, 1995; Heeter, 1992). Unfortunately, once technology is added to an educational situation things tend to lose their simplicity. Realizing this, Hillman, Willis and Gunawardena (1994) pointed out that although the two-way audio/video environment has the potential to provide real-time interaction, significant impediments might result if the student is not comfortable with the technology or if the technology is poorly implemented. We believe that anxiety induced by the physical environment in a two-way audio/video classroom will affect students' interaction and in turn their satisfaction.

The idea that anxiety has hindered learning is well established (Eysenck, 1979; Darke, 1988). It has also been established that when students are anxious, they will feel less comfortable speaking in groups (Weinberger & Engelhart, 1976). In sum, given a large classroom with a number of anxious students, it is likely that the overall quality of interaction and success of a class will suffer. There are numerous ways to combat this anxiety, but one way is to establish a safe and comfortable environment. In a traditional classroom where there are few and familiar environmental variables, this is relatively simple. However, in a two-way audio/video classroom there are numerous and less familiar variables. In addition, the use of technology itself can be quite anxiety-provoking for some individuals (Rosen & Maguire, 1990; Mahmood & Medewitz, 1989).

The physical environment is one of the foundations on which a comfortable anxiety-free classroom is built. Careful planning of a two-way audio/video classroom can ease communication and interaction; failure to do so can be not only unhelpful, but detrimental (Cape, 1996). Although a plethora of techniques can aid in reducing and facilitating communication and interaction in the classroom, using any of these methods in the absence of a sound foundation is analogous to a well-conceived building placed on a fault line. In the end, these interventions would collapse into the base from which they were built. Careful planning and judicious support in a two-way audio/video classroom play an important part in establishing a solid foundation.

There are several factors that should be addressed in order for a two-way audio/video class to be successful. Factors such as lighting, audio quality, table and monitor arrangement can all affect a student's anxiety level. In addition, unintelligible audio or video portions of the class can also create a whole new set of stressors that may hinder learning. Curiosity may induce some students to enroll in a video conference course, but others are likely to be unnerved by seeing themselves on the video monitor (Bruce & Shade, 1995). The technology in this environment can be particularly disconcerting for people. For this reason, the availability and response time of technical support staff in this type of environment is also crucial. If a problem with the technology arises and it is not resolved quickly, the anxiety and frustration level of all participants is likely to increase. Essentially it is important that the technology, environment, and support work together seamlessly, lest the environment become intrusive and anxiety-provoking thus compromising the level of interaction.

Although two-way audio/video classrooms have been around for over 40 years, there has been little empirical examination of physical environmental variables and, in particular, students' perceptions and satisfaction with them (Biner, Dean, & Mellinger, 1994). According to McIsaac and Gunawardena (1996) "... research is needed to identify how technology interacts with students and how it affects teaching and learning." Additionally, research on how the technology affects learners as well as the environmental conditions necessary for its implementation should be ongoing (McIsacc & Gunawardena, 1996.) This is especially true as the technology changes.

In this study we seek to develop a method by which to assess physical and environmental aspects as well as students anxiety in this type of environment and their overall satisfaction with their learning experience. Although many elements make up a solid foundation in the classroom environment, we believe that environmental variables are particularly relevant to student anxiety level, satisfaction, and ultimately student success in the classroom. Furthermore, it is essential that educators and programmers take these elements into account when developing and conducting distance education classes. The success level of the students, the instructors, and ultimately the distance education program can only be as good as the foundation on which it lies.

Method

Participants

The participants for the study were students enrolled in 12 separate two-way audio video classes at two major midwestern universities and two midwestern community colleges. The sample consisted of 222 subjects (146 female, 54 male, 22 non-reported; 93% Caucasian, 4% African American, 1% Hispanic, 1% Asian, 1% other). The age range for the sample was 18-64, with a modal age of 19 and a mean age of 31. 97% of the participants were native English speakers.

Instruments

The instruments used in this study included the following measures: anxiety in a two-way audio/video classroom, general satisfaction with the distance learning experience, and student perception of environmental elements of the two-way audio/video classroom. Environmental variables were subdivided into three categories: perception of the physical environment, perception of the physical layout, and perception of the management of the distance learning environment.

The measures in this study were developed due to the lack of empirically validated instruments that assess these constructs. Developing these measures was a multi-step process. The initial items were developed through a combination of techniques. In the case of the anxiety measure, items from the STAI: The State-Trait Anxiety Inventory (Spielberger, Gorusch, & Lushene, 1970) were examined and then modified to address specifically a two-way audio/video classroom situation. Additionally, the items in this inventory were designed in such a way that a high score would represent low anxiety. This was done so that there would be uniformity among the different measures. Thus, a high score on any of the measures would represent a positive attribute.

An approach similar to the development of the anxiety measures was used for developing the satisfaction with learning experience measure. Consumer satisfaction has been an important area of research in many fields (Ware, 1978; Lebow, 1982; Locke, 1976). In the past decade this area of research has gained interest in the area of education (Chadwick & Ward, 1987). As competition for students grows, particularly in distance education environments, schools will need to pay close attention to this variable lest their programs become victims of low retention and returns. Although the fields studied vary each seems to tap a certain unidimensional factor in its assessment of consumer satisfaction. Larsen, Attkisson, Hargreaves, and Nguyen (1980) in their development of Services Evaluation Questionnaire, found that three items defined a unidimensional measure of satisfaction.

1. To what extent has our program met your needs?
2. In an overall general sense, how satisfied are you with the services you received?
3. If you were to seek help again, would you come back to our program?

These three items were used as a guideline for the initial development of items to assess satisfaction with learning experience.

Finally, in developing a measure to assess environmental aspects of a two-way audio/video classroom, we interviewed ten distance education educators and four technicians from two large midwestern universities. Specifically we asked them questions regarding their own experiences and their students' perceptions of the distance education environment. This information was then summarized and categorized into different environmental issues for two-way audio/video environments. Individual items were derived from these categories.

Once the base set of items for each of the inventories was created, three experts in the field of distance education were given the items and were asked to rate how accurately the items measured each of the constructs. Additionally, a rating procedure was used in which 66 novices, students in educational psychology courses, were given definitions for each construct and asked to identify which construct each of the items seemed to measure.

The definitions used for each construct are as follows:

Anxiety: Fearful concern about performing and/or learning in a two-way audio/video classroom. Apprehension regarding one's capacity to cope with a two-way audio/video environment, despite having adequate preparation.

Satisfaction with the learning experience: How satisfied one was with their learning experiences in a two-way audio/video classroom.

Physical Environment: Perceptions of various physical characteristics of the two-way audio/video environment, such as audio, video, and so on.

Physical layout: Perceptions of the physical layout of a two-way audio/video classroom.

Management of the two-way audio/video classroom: Perceptions of how well the instructor and/or technology support team was able to manage successfully a distance learning environment. Management includes the support and use of the two-way audio/video technology, as well as regular classroom management.

Using these definitions, students were asked to categorize each item. Participants were allowed to choose one, multiple, or none of the constructs when making this decision. Next, concordance rates among these students were calculated.

The items eventually chosen for each of the scales had a wide range of frequency ratings from the novices. When examining these results, we looked at two specific areas. First we examined the percentage of identifications for the selected definition alone and then we looked at the number of identifications for something other than the selected definition. For the anxiety items there was a 64% - 91% selection of the anxiety definition alone with no other choices or combinations above 15%. For the satisfaction with learning experience there was a 26%-79% selection of the satisfaction with learning experience alone. The two items with the smaller confirmation rates also had confirmations of 25% and 17% for the no matches choice. The environmental variables, almost uniformly, were confirmed as one or a combination of the three environmental choices. The overall percentages for confirmations as one or a combination of the three environmental variables ranged from 48% - 98%, with only two of these items below the 75% rate. However, when these items were broken down into the three individual environmental categories the novices confirmation rate dropped considerably. The only category with reasonable sole confirmation rates was the physical layout, with confirmation rates ranging from 60%-85%. Of these items only one item, environmental perception, had an additional choice equal to or above 15%.

The concordance rates of all of these items were examined in conjunction with the expert ratings. Based on these results, items were divided among the previously stated constructs.

Finally, each of these items were given to the students in two-way audio/video classes. The students were asked to rate how strongly they agreed with each of the items. Ratings were given using a six point rating scale with one being **strongly disagree** and six **strongly agree**. Item analysis was performed using coefficient alphas. From this analysis 3 additional items were removed that did not, contribute additionally to the measurement of the construct in question and detracted from the overall homogeneity of the measure. From these procedures five scales were developed to assess each of the constructs in question.

The measures included items such as; "Talking on the camera frightens me" (Anxiety: 5 items); "I would take another two-way audio/video class" (Satisfaction with learning experience [SLE]: 6 items); "The lighting in the room is good" (Physical Environment [PE]: 7 items); "The layout of the room makes interacting with people at my site easy" (Physical Layout [PL]: 4 items); "The technology support for this course is good" (Management of the two-way audio/video classroom [MTAV]: 6 items). Reliability analysis was performed on each of the constructs. Each measure was found to have acceptable internal consistency (Anxiety = 0.87; SLE = 0.90; PE = 0.77; PL = 0.77; MTAV = 0.71). Final scores for each of the measures was obtained by adding each of the items for the specific construct and then obtaining the mean.

Procedures

The data collection took place over two semesters. Nine classes participated during the spring semester of 1997, and 3 classes participated during the fall semester of 1997. During the 13th week of class, a questionnaire was administered to each participant. The questionnaires consisted of several items assessing a variety of topics including the anxiety, SLE, PL, PE, and MTAV constructs. Before receiving this questionnaire the participants received an informed consent form, and they were asked to participate voluntarily in the study. Standard human subject procedures were followed as designated by each school's human subjects committee.

Analysis and Results

Scores on each of the five measures in question (anxiety, SLE, PE, PL, MTAV) were obtained for each of the students. Bivariate correlations were run on these scores. All of the measures were significantly correlated to alpha = .01 level. The results of the correlation are displayed in table 1.

Table 1. Bivariate correlations for anxiety, satisfaction with the learning experience, perception of the physical elements in the environment, perception of the physical layout, and perception of the management of the two-way audio/video classroom.

	Anxiety	SLE	PE	PL	MTAV
Anxiety	1.0				
SLE	.344**	1.0			
PE	.322**	.601**	1.0		
PL	.341**	.647**	.674**	1.0	
MTAV	.350**	.658**	.634**	.581**	1.0

(** Correlation is significant at .01, two-tailed.)

Next step-wise multiple regression analyses were performed to examine the contribution of the different physical environment aspects (PE, PL, MATV) to the constructs in question: anxiety and satisfaction with the learning environment. The results of the regression analyses are displayed in table 2.

Table 2. Step-wise multiple regression coefficients (standardized) for perception of the management of the two-way audio/video classroom (MTAV), perception of the physical elements in the environment (PL) and perception of the physical elements in the environment (PE). Anxiety and satisfaction with the learning experience are the dependent variables.

Variable	Anxiety	Satisfaction
MTAV	.229**	.376***
PL	.208**	.336***
PE	----	.136*
R squared	.151**	.547**

* p < .05
** p < .01
***p < .001

The results of the anxiety regression analysis (Table 2) indicate that together MTAV and PL explain a significant portion of the variance in students' anxiety with an R squared value of .151 (with p < .01). Additionally, MTAV and PL individually explain a significant amount (p < .01) of the variance in students' anxiety. The step-wise procedure excluded the independent variable PE in the anxiety regression analysis. The exclusion of this variable may be due to multicollinearity among the independent variables.

The satisfaction regression analysis (Table 2) indicates that together the three independent variables: MTAV, PL and PE explain a significant portion of the variance in students' satisfaction with the learning experience with a R squared value of .547 (with p < .01.) Individually, each of the three independent variables: MTAV, PL and PE explain a significant amount (p < .001) of the variance in students' satisfaction with the learning experience.

Discussion

In this study, focus was placed on a few of the foundational elements of a two-way audio/video classroom. The results suggest that ignoring these elements can lead to a shaky foundation that will ultimately affect student anxiety and satisfaction with learning. In general, the results of the bivariate correlation indicate that there is indeed a significant positive relationship between students' perception of environmental aspects (physical elements, layout and management of the distance learning experience) and students' anxiety level and their satisfaction with the learning experience. Furthermore, the regression analysis provides support that the students' perception of the physical elements in the environment and the management of the distance learning experience explain a significant portion of the variance of the students' anxiety. Additionally, students' perceptions of the physical environment, the layout of the environment, and the management of the distance learning experience explain a significant portion of the variance of students' satisfaction with the learning experience. Last, there are some issues regarding our results that need to be investigated further, which we will discuss in detail below.

The items within each of the scales we developed, at face value, appear to be measuring different, but related constructs. However, as can be seen by the correlation analysis, they hold a very high relationship among themselves. In respect to the environmental perception sub-scales, caution should be exercised when distinguishing one of these specific aspects from another. This problem can be seen in the first regression analysis in which the PE variable was excluded. The fact that it did not significantly contribute to the explained variance of anxiety could be due to multicollinearity effects. It is important to note that the multicollinearity may not be the fault of the measures. It seems quite possible, given the distinction novices and experts attributed to the question in the measurement construction phase and the quite opposite finding when administering it to distance education students, that people simply do attribute different values to these distinct constructs. In other words, students may simply be answering all of the items in one general direction or the other and not making any finer distinctions. To better assess the environmental impact on student anxiety and satisfaction, a controlled experiment in which the environment was manipulated would need to be done. Yet despite these problems with the measures, they do hold promise for explaining overall perceptions of environmental aspects as well as a good beginning for further refinement in the measurement of specific environmental aspects in a two-way audio/video classroom.

As originally hypothesized, student anxiety and satisfaction are indeed related to their perception of environmental variables. This study provides the first steps in determining what can be done to help alleviate anxiety in a situation that for many is, by nature, anxiety provoking. In addition it provides yet another way to address student retention and ensure that future enrollments continue. Although the relationship appears to be fairly strong, the study leaves several questions for further exploration.

Further Research

The number of empirically validated measures that assess the environmental aspects of a two-way audio/video environment are few (Biner, Dean, & Mellinger, 1994). In fact we could not find any measures that specifically addressed this question. Thus, in the first portion of our study we sought to establish measures that could assess each of the various elements in the two-way audio/video environment (physical elements, layout and management of the classroom), students' anxiety level, and satisfaction with their learning experience. A multi-step process for developing these measures was used. Each measure had an acceptable internal consistency level and experts as well as novices provided ratings that indicated a high level of face validity. Although this is an important first step, additional data needs to be gathered so that validity can be established through other statistical techniques such as confirmatory factor analysis. Additional support for validity can be provided through an examination of the relationship between measures that examine the same or similar constructs. Finally, a controlled experimental study should be done in which elements in the physical environment are held constant. This will then assist in determining which elements in the environment are influencing students' attitudes. This will also help in determining if students' attitudes are influenced by their perception of different, distinct elements in the environment or as one overriding environmental construct.

The study sought to obtain a measurement of students' perceptions of the environment. This was deemed important because it is how students perceive the environment that is most likely to be related to their level of anxiety. However, before designers can make blanket decisions about how to create a two-way audio/video environment, the perception of environment must be validated against actual observations of the environment by experts. If it is found that students' perceptions are accurate, this can lead to further refinement and investigation into which aspects of the environment play an important part, in student's anxiety and/or satisfaction. Once these relationships are determined further studies can examine if different layouts, types of equipment or support make a significant impact on the students' anxiety level and satisfaction.

In the immediate realm, the study provides evidence that the foundational elements in a two-way audio/video classroom – the physical elements of the classroom, the design of the classroom, and the support and management – are important elements in regards to students' anxiety and satisfaction with the learning experience.

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Layers of Navigation: Hypermedia Design for an Ill-Structured Domain

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Abstract

In this article, two web sites developed specifically as curriculum resources for art educators are presented. While the sites were not designed to address specific principles of cognitive flexibility theory, we make a case that a thematic approach to inquiry-based art education delivered in a hypermedia environment designed with three layers of navigation is appropriate for an ill-structured domain such as art. An early response from teachers participating in an on-line seminar suggests that the complexities of inquiry in art are well presented in a hypermedia environment, that reductive bias is minimized, and that this environment is useful, relevant, and accessible. This article focuses on the development of the sites and describes a framework for three blended levels or "layers" of navigation that support knowledge construction within the domain: near-linear, guided, and self-directed exploration. Recommendations for application of this framework for other hypermedia and hypertext curriculum resource environments conclude the article.

Too often, web sites are developed for instructional uses without the aid of sound instructional design principles. These sites appear on lists of Internet resources for teachers and can confuse novice computer users and novice teachers. Content is presented as static, verbal information pages linked to other information pages that may or may not include obvious or intuitive navigational cues. That is, information is delivered with the new technology but the format of the presentation may confuse or "lose" the novice and intermediate user.

Designing instruction for instructional hypermedia and hypertext requires thoughtful attention to certain aspects of learning, particularly when designing for ill-structured domains. Over-simplification of the complexities of an ill-structured domain encourages novices to reduce the "solutions" of domain-specific problems to simplified or cook-book answers, which is known as reductive bias (Spiro, Feltovich, & Coulson, 1992).

In ill-structured domains such as art, an over simplification of the domain (e.g., the reduction of learning in art to production skills and selected historical data), masks the complexities of cultural context and the interconnectedness of aesthetics, criticism, production, and history in the art world. Similarly, teacher education programs in art and in-service opportunities for novice art teachers or classroom generalists (elementary educators); have in the past reduced the art experience to a production of "happy hands and holiday" non-art projects.

In this article, two web sites (Erickson, 1996; Erickson & Cárdenas, 1997) developed specifically as curriculum resources for art educators are presented. While the sites were not originally designed to address specific principles of cognitive flexibility theory (Jacobson, 1995; (Spiro, et al., 1992), we make a case that a thematic approach to inquiry-based art education delivered in a hypermedia environment designed with three layers of navigation is appropriate for an ill-structured domain such as art. An early response from teachers participating in an on-line seminar suggests that the complexities of inquiry in art are well presented in a hypermedia environment, that reductive bias is minimized, and that this environment is useful, relevant, and accessible (seminar discussions may be found at: http://www.artsednet.getty.edu/ArtsEdNet/hm/May97/0006.html). This article focuses on the development of the sites and describes a framework for three blended levels or "layers" of navigation that support knowledge construction within the domain, both in terms of new content knowledge and as an approach for novice teachers to use to teach art. Recommendations for application of this framework for other hypermedia and hypertext curriculum resource environments conclude the article.

Relevance, Usefulness, and Accessibility of Hypermedia Environments

Much has been written about the educational potential of hypermedia environments such as the world wide web (WWW), however, not all web sites or CD's are educational in their intent. For purposes of this article, we will define educational hypermedia as those environments designed and developed specifically for use as educational resources or as a basis for instruction.

Elements of Educational Hypermedia Environments

The relationship between the site and the user. Successful educational and instructional hypermedia environments are more than the information presented. That is, in successful educational web sites, there appears to be a synergistic relationship between the information at the site, the authors of the site, and the users of the site. Several articles have identified elements of this synergy (Barrett, 1992; Carlson, 1991; Corry, Frick, & Hansen, 1997; Hill & Hannafin, 1997; Jonassen, 1991; Jonassen & Wang, 1993; Locatis, Charuhas, & Banvard, 1990; Schroeder, 1994; Spiro, et al., 1992; Spiro, Feltovich, Jacobson, & Coulson, 1991), but few have presented them as a unified whole. Table 1 is a first attempt at illustrating the user and site characteristics designers consider when developing successful educational web sites.

Table 1. Elements of Hypermedia Learning Environments

Learner/User Elements	Site Elements
Computer Skills	Content
Content Knowledge	Presentation
Self-efficacy	Navigation
Learner Control	Links and Nodes
Task type	

Hill and Hannafin (1997) recently identified several learner/user elements illustrated in Table 1: Computer skills, or the ability to use the computer and by implication a WWW browser, was defined as system knowledge (p. 39). They defined content knowledge specifically as prior subject knowledge (p. 39). Such prior knowledge is critical to the acquisition of new subject or content knowledge. Self-efficacy "...refers to a personal judgment of one's capability to execute actions required to perform" (p. 39). In other words, the confidence of the learner/user in his or her ability to use the computer and link new information to previously learned information has a great impact on how one uses the site and on how much the learner/user will persevere in acquiring new information.

Learner control is another element that has been discussed at length in designing effective instruction (Hooper, Temiyakarn, & Williams, 1993; Malone & Lepper, 1987; Morrison, Ross, & Baldwin, 1991; Ross & Morrison, 1992) and is of particular relevance in hypermedia environments. However, because of the complexity of ill-structured domains, total learner control may not be an effective design feature. Cognitive overload may occur as learners branch further and further from the site in search of content knowledge (Spiro, et al., 1992).

Related to learner control is task type. The type of task a learner/user has in which a learner engages when entering an educational hypermedia environment appears to determine his or her path through the site (Barab, Bowdish, & Lawless, 1997). From an art education perspective, task type in an ill-structured domain such as art is closely tied to thematic and inquiry-based learning (discussed below) in that the theme and line of inquiry shape the task.

Previous researchers (Conklin, 1987; Jacobson & Spiro, 1995; McLellan, 1993; Recker, 1994; Schroeder, 1994) have identified site elements using a variety of terms. We will consider the list in Table 1 as a basis for our discussion of site versus user elements. The site elements Content, Presentation, Navigation, and Links and Nodes; refer to the information itself, how it is presented to the learner/user, how the learner moves within the site, and how information is linked to other information respectively.

While either set of elements might be considered separately, hypermedia design appears to be most successful when it is purposefully designed to cross learner/user elements with site elements. Though most educational hypermedia environments must address all of the elements in some degree, our focus in designing the three layers of navigation is primarily on task type and navigation.

Macro and micro conditions of hypermedia design. In addition to learner/user elements and site elements, three conditions for educational hypermedia appear to play a role in the success or failure of the hypermedia environment to support and facilitate learning: relevance, usefulness, and accessibility. Each condition has two levels that incorporate the larger educational context of the user (macro level) and the user as an individual (micro level). Table 2 presents these conditions related specifically to art education.

Table 2. Macro and Micro Levels of Relevance, Usefulness, and Accessibility of Hypermedia Learning Environments

Condition	Macro Level	Micro Level
Relevance	Relevant to social, institutional (school), community, and curricular expectations.	Personal relevance to teacher and learner: the environment affords connections to prior experience and/or aids in delivery of instruction in local learning context and discipline.
Usefulness	Appropriate presentation of instructional (and artistic) media for structured and ill-structured domains.	Use of the hypermedia environment reinforces teaching and learning in art content areas.
Accessibility	Socio-cultural implications of accessing hypermedia: race, gender, socio-economic status, availability of technology, and the ability and skills needed to use technologies.	User interface or presentation: organization of content, verbal and non-verbal presentation, graphic, thematic, or concept map navigation within the instructional application facilitates learning and minimizes disorientation.

Relevance. Relevance refers to the relationship the product and idea technologies have to the user. Relevance, in the sense of the ARCS model of motivation theory (Keller, 1979), is the condition that mediated instruction should be connected to the teacher and learner's personal goals and values. Relevant web sites for instructional needs are often a matter of individual perception, but may well be a matter of availability of appropriate (relevant) sources. For example, graphic software is highly relevant to art production classes but may be less relevant when discussing aesthetics.

Usefulness. Usefulness, as defined for this article, is the condition that relates to the application of different hypermedia environments to learning. Usefulness also describes using the technologies to the appropriate level of their potential, and in the appropriate macro and micro context. The technology may be very relevant to the instruction (e.g., a downloaded educational game in art history) but might be found to be useless in terms of learning: the game is fun but contributes little to the learning context. Usefulness in our definition should not be confused with usability (Corry, et al., 1997).

Accessibility. Accessibility on a macro level, refers to the social and cultural constraints, capabilities, and implications of access to the hypermedia environment and to the technology (Borrell, 1992; Piller, 1992), particularly in the areas of race, socio-economic status, and gender. On a micro or local level, accessibility is concerned with socio-cultural issues but focuses attention on individual access and use of the technology and the hypermedia environment.

Ill-structured Domains and Cognitive Flexibility

Novices in ill-structured domains have several difficult obstacles to overcome before they are welcomed into the culture of the expert. Medical students encounter patients whose symptoms do not conform to textbook examples, budding physicists struggle to leap from ordered word problems to speculating on the nature of motion, and student teachers find that teaching methods are seldom performed "by the book" in real classrooms. Novice art educators have the added task of dealing with a content area that is so ill-structured that it is often assumed to lack substance or discipline.

Ill-structured domains are those which may be characterized as having two distinct and interconnected properties: "concept- and case-*complexity*," and "across-case *irregularity*" (Spiro, et al., 1992, p. 25). Briefly stated, concept and case complexity requires that learners (students, artists, teachers) hold several often conflicting concepts in mind when confronting a case within the domain. In art, cases may be particular problems in aesthetics, history, criticism, or creating a work of art. For example, seeking to understand an artwork from another culture, such as a 19th century Sioux decorated container (art history problem) may require one to hold in mind such diverse concepts as climatic conditions, the relationship of geometric shapes, and pre-industrial art making techniques (Erickson, 1996). In advanced art courses, case complexities and irregularities such as these increase across art media and art concepts.

The irregularity of similar cases, that is, the necessity of applying different concepts and actions to a case that might resemble a previously encountered case, is often encountered in art and may indeed play a major part in how art movements are started. For example, an aristocratic portrait from Colonial New Spain; a representation of the Mexican Revolutionary hero, Zapata; a mural by Diego Rivera; and a feminist self portrait as the Virgin of Guadalupe (Erickson & Cárdenas, 1997) are examples of an application of very different concepts and actions to the "common" problem case of painting a portrait.

The two web sites described in this article are designed to guide and support the art educator in developing curriculum for art education while providing some sense of case complexity and irregularity. The above examples of case complexity (seeking to understand artwork from another culture) and case irregularity (portrait painting) are illustrations drawn from the two web sites. In turn, the lessons and supplements presented provide the K-12 art students with some insight and a window on learning in art. Well designed instructional hypermedia and hypertext environments should offer learners rich and challenging instructional contexts that foster learning in complex or ill-structured domains. Novice learners in such domains as art or medicine, are largely struggling to understand the complexities of the domain itself. Add to this the necessity of learning with and from an educational technology that affords a non-linear mode of accessing information, and the result can be disorientation and cognitive overload (Conklin, 1987; Jacobson & Spiro, 1995; Spiro, et al., 1992).

By overlaying the information with a thematic and inquiry-based organizational scaffold and through the application of sound instructional design elements, much of the confusion and disorientation can be minimized without sacrificing the presentation of the complexities of the domain. We identified navigation as the most critical support for the thematic and inquiry-based approach to this domain.

Thematic and Inquiry-based Learning

In "Our Place in the World" (1996) and "Chicana and Chicano Space" (1997) web sites, content is organized within a thematic, inquiry-based approach that uses a series of questions to help students' learning. Students in the K-12 art education classroom learn to formulate additional questions and search for answers through their own art experiences and by researching appropriate sources. Learning in a thematic, inquiry-based classroom is student-centered rather than teacher led; and encourages student elaborations on the themes and questions to promote deeper processing (Hannafin & Carney, 1991; Wilson & Cole, 1992).

Our Place in the World (1996) focuses on four key inquiry questions:

1. How is the reproduction different from the original artwork?
2. How was the artwork made?
3. What visual elements did the maker choose?
4. What was the natural world like where the artwork was made?

Students explore art making questions related to four inquiry questions and apply the inquiry questions when they make their own art and when they study two artworks from the past (an Ice Age cave painting of a bison and a 19th century Sioux parfleche case). The theme, Our Place in the World, provides an overall direction for thinking about the two art works as they relate to each student's new experience in art.

Chicana and Chicano Space (1997) presents another inquiry-based, thematic unit called "Protest and Persuasion." This unit focuses on the following key inquiry questions:

1. What can I learn about the tools, materials, and processes the artmaker chose?
2. What can I learn about how the patron, user, or viewer understood the artwork?
3. What visual elements do I see?

Students apply the three inquiry questions to art making as they plan and produce their own print or mural and as they investigate the twenty Chicana/Chicano, Mexican, and Mesoamerican artworks posted on the site. The theme of Protest and Persuasion provides a focus for their thinking about these artworks as well as for their own art making experience.

Thematic instruction from a teacher's perspective is not new. Themes, particularly in elementary classrooms, provide a useful means to support deeper understanding and a context for learning. In ill-structured domains, thematic instruction guides students through the learning context by following a theme through a variety of situations thus promoting an experiential learning context with guidance to facilitate learning. Key inquiry questions help students understand the domain and can introduce new levels of complexity without overwhelming the student. In this way, the task of moving through the site is organized around themes and inquiry rather than strictly by linear step-by-step links, though novice teachers may navigate the site in a variety of ways.

Layers of Navigation

"Our Place in the World" (OPITW) and "Chicana and Chicano Space" (CCS) curriculum resource web sites were designed for teachers to use rather than for K-12 students. Within the sites, sets of lesson plans and suggested paths are presented that help the teacher develop a thematic, inquiry-based approach to art education. Beginning and experienced art teachers often have a difficult time presenting the world of art and its complexities to their students. While the themes and questions suggest certain paths through the content, navigational considerations for beginning and experienced teachers were needed.

As the prototype for OPITW was formed, we found that the natural flow of the content design could become too linear if translated directly from the lesson plans to a hypertext or hypermedia environment, even though we had the option of hot linking terms and ideas. When these materials are presented in a classroom to beginning teachers, a large amount of dialog and experimentation with themes and questions becomes the focal point of the class. Our vision was to create a site that could provide this kind of interaction with the content and yet at the same time guide the novice user and beginning teacher through the materials.

To accomplish this goal, three layers of navigation; near-linear, guided, and self-directed exploration; were designed to address the needs of novice teachers without sacrificing the complexities of the content. These layers roughly parallel the three levels of use described in the Jasper Series from the Cognition and Technology Group at Vanderbilt (CTGV) (1992).

There, through a series of scenarios, K-12 learners are presented with learning tasks that are "anchored" to "real world" problems; an approach CTGV described as anchored instruction. The Jasper Series, as envisioned by the CTGV, allowed three levels of use; each level progressively less dependent on direct instruction. However, the Jasper Series materials retain many of the characteristics of instruction designed with traditional ID models: the materials tend to be design dependent, follow a somewhat prescriptive model, and are intended for a large audience, even though they take a more constructivist approach.

The levels of use for the Jasper Series attempts to address each continuum within each dimension. The Basics First level provides a means of teaching the components of solving Jasper problems, such as decimals, measurements, time, etc. before viewing the problem scenarios. Structured Problem Solving, the second level in the Jasper Series, provides a means of introducing complex problems with simple problems to help students avoid error and to break down complex problems into simple components. The third level, Guided Generation, provides a flexible context in which the problem is approached through cooperative groups, some guidance by the teacher as a resource, and the development of inquiry skills based on Vygotsky's (Vygotsky, 1978) concept of scaffolding.

The three layers of navigation in OPITW, while based on the model of CTGV's levels of use, are specifically designed for the teacher rather than for their students, and allow greater control than websites with only one or two layers of navigational strategies. Novice teachers and those who are more experienced, may move through the sites using three distinct navigation paths.

Near-linear Navigation

Near-linear Navigation may be defined as the path through the web site apparent from the homepage. That is, the OPITW and CCS web sites imply a path from Lesson One to Lesson Two and so on through each site, rather like the Basics First approach. Supplements and Extensions in OPITW might typically be accessed after all of the core lessons have been completed, and is very similar to a more traditional instructional approach. We see this strategy layer as being "near-linear" in the sense that users typically follow the path from one step to the next in sequence, but there is always an option for branching to other links, sections of the site, or different sites. OPITW and CCS are not closed or stand alone sites.

Guided Navigation

The Guided Navigation strategy layer allows the user to utilize a set of outlines, questions, or thematic paths provided on-line to structure navigation through the site. To further support Guided Navigation, a set of simple icons was created to graphically represent each of the themes and sets if inquiry questions. Thus teachers may explore themes in art education specifically or across content areas as an integration plan by individual schools. Materials included in OPITW and CCS may be accessed selectively for specific applications guided by the needs and parameters of the integration plan.

OPITW and CCS include a built in guided navigation strategy featuring the use of graphic icons. Teachers may click on an icon symbolizing the key inquiry questions as an alternative, less linear strategy for accessing curriculum materials. The guided questions and use of icons were a useful, relevant, and accessible means of helping novice teachers move through the sites' content and to expand upon thematic concepts.

In addition, a second guided navigation strategy is available to assist teachers in considering how themes and inquiry can improve their own teaching. An on-line seminar provided participating teachers with reflective questions, short tasks, and guided instruction during the first few months of the OPITW's availability on the Internet. A listserv moderated by the second author was put in place to provide an ongoing dialog with an expert while teachers used the site in their own classrooms. In this way, OPITW actually includes two types of guided navigation: those designed into the site as icons, themes, and inquiry questions; and those that were specifically asked during the on-line seminar sessions.

It is beyond the scope of this paper to discuss the results of the this Guided Navigation layer except to mention that teachers' response to the listserv and tasks were positive (see http://www.artsednet. getty.edu/ArtsEdNet/hm/May97/0006.html). In many cases, this layer functions as another "theme" when using the site in the sense that teachers are guided by the tasks or needs of their curriculum plans. Further discussion of this layer will be available in a later article.

Self-directed Exploration

"Our Place in the World" and "Chicana and Chicano Space" may be accessed by experienced teachers who require the site to serve as a curriculum resource rather than a tool for improving their teaching. Ideas, key artworks, detailed information, inquiry questions, and icons, as well as the themes, may inspire more in-depth exploration throughout the WWW. In fact, "Protest and Persuasion" on CCS concludes with a lesson in which students are asked to use the theme to guide their own cruising of the WWW. OPITW and CCS offer a framework for lesson planning and curriculum development, yet at the same time foster further exploration of the domain.

Recommendations

Based on our experiences and on sound instructional design practices, we suggest that designers of web sites and other hypertext or hypermedia environments intended as educational or instructional resources for ill-structured domains consider the following set of considerations as a framework for good design:

1. Consider the elements of hypermedia environments and purposefully design for "cross over" between learner/user and site elements. By striving to merge site and user characteristics as illustrated in Table 1, designs for educational hypermedia environments become more useful, relevant, and accessible for a variety of novice to expert users. Sites that focus only on one set of elements (learner/user or site specific elements) may be appropriate for presenting verbal information, but are not useful for learning in ill-structured domains such as art.

2. Consider the segments of the domain to be presented. Use a thematic, inquiry-based approach to engage students in the content and to control cognitive overload. The sites discussed in this article make no attempt to cover the entire world of art. Rather, they guide learner/users through a series of strategies for moving through the domain by asking questions and by attending to suggested themes. Thus the domain is well represented, yet cognitive overload is reduced.

3. Reduce reductive bias by presenting a variety of cases with open-ended solutions. Increase complexity of the cases by presenting alternative extensions to the cases. Thematic inquiry-based learning provides a means of presenting cases with increasing complexity. By encouraging elaborations and curriculum extensions, case complexity and irregularity can be addressed as typical of an ill-structured domain.

4. Use a layers of navigation approach to support a variety of strategies for moving through the site and to facilitate learning in an ill-structured domain. If the designer pays attention to the interaction of site and user elements rather than to individual elements, the design has a greater chance of presenting the complexities of the domain while reducing disorientation and reductive bias.

Further experimentation in designing layers of navigation strategies for ill-structured domains is needed. The flexibility of instructional hypermedia and hypertext designs provide more opportunities to address higher order thinking in ill-structured domains. By attending to the elements of instructional hypermedia environments (learner/user and site specific) and by meeting the conditions of relevance, usefulness and accessibility; designers can meet the needs of learning in ill-structured domains. Developing and refining navigation strategies for instructional hypermedia such as the three layers of navigation described above, will aid novices and experts in understanding the complexities of ill-structured domains while avoiding reductive bias.

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Learner Ability and Learner Control: A 10 Year Literature Review 1987-1997

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Abstract

This paper examines research studies of learner control in computer-based instruction (CBI) from 1987-1997. Previous literature reviews (Chung & Reigeluth, 1992; Ross & Morrison, 1989; Steinberg, 1989; Williams, 1992) have drawn predictions and recommendations from earlier learner control research. This review evaluates these earlier conclusions in light of current research, and discusses the implications of recent findings for instructional development.

Learner control, defined as allowing students to make choices among instructional events during a lesson (Schnackenberg & Savenye, 1997) has been investigated with learners at a variety of ages and grade levels, using lessons covering a wide range of content and educational outcomes. The idea of giving learners control over elements of their instruction has been popular among educators for decades. One reason often advanced for learner control is that learners know their own instructional needs best and therefore are uniquely qualified to tailor instruction to these needs (Mager, 1964; Merrill, 1975, 1980). Previous reviews, while encouraging the idea of learner control, have called the effectiveness of learner control "equivocal" (Williams, 1992), "inconsistent, but more frequently negative than positive" (Ross & Morrison, 1989), and "inconclusive, and...more frequently negative" (Chung & Reigeluth, 1992). Researchers have continued to investigate the concept of learner control, seeking to isolate features that might enhance or decrease learner performance.

One factor affecting learner achievement may be general ability or aptitude (Cronbach & Snow, 1977). Williams (1992) points out that some studies confound general ability with prior knowledge. Learner ability is associated with the concept of general intelligence (Williams, 1992), while prior knowledge is referred to as the amount of information a learner has previously acquired on a particular topic or subject. Prior knowledge of content is generally measured through a pretest administered before assignment to an instructional treatment, whereas general ability is measured via standardized tests that assess general aptitude. In the studies under consideration in this review, ability measure include standardized reading tests (Carrier & Williams, 1988; Kinzie, Sullivan, Beyard, Berdel, & Haas, 1987); Scholastic Aptitude Test (SAT) and American College Testing Assessment (ACT) (Schloss et. al, 1988; Schnackenberg & Sullivan, 1997); the Henmon-Nelson general ability test (Klein & Keller, 1990); a figures rotation test (McGrath, 1992); and a standardized math achievement test (Hannafin & Sullivan, 1995).

The use of standardized test scores rather than prior knowledge examination scores in the aforementioned studies enables the reported achievement results to be attributed directly to either the design of the CBI lesson utilized or general student ability, and not to the information and skills subjects may have learned prior to studying content in the instructional programs. This type of isolation of learner knowledge allows the specific aspects of the learner-control/learner ability question to emerge in clearer detail and not be mitigated by subjects' content knowledge in a specific area. It is for this reason that this review focuses only on studies that measure learner ability via standardized tests because it is only in this way that accurate conclusions can be drawn about learner control and students' general intellectual ability.

It has been suggested that lower-ability learners should score higher on posttests under program control, i.e. when the program delivers all possible instructional events in a prescribed sequence. Chung & Reigeluth (1992) suggest that lower-achieving learners lack the knowledge and motivation to make appropriate decisions regarding their own learning needs, making learner control less effective for them. Steinberg (1989) makes a similar argument for reserving learner control for higher-ability students, since these students' metacognitive strategies may be presumed to be better developed.

To investigate a possible interaction between ability and learner control, a number of recent studies have used ability measures as a blocking factor (Carrier & Williams, 1988; Hannafin & Sullivan, 1995; Klein & Keller, 1990; Kinzie, Sullivan, Beyard, Berdel, & Haas; 1987; Kinzie, Sullivan, & Berdel; 1988; McGrath, 1992; Schloss, Wisniewski, & Cartwright, 1988; Schnackenberg & Sullivan, 1997). None of these studies revealed an interaction between ability and type of control. The lower-ability students did not perform any better under program control (where learners could not choose instructional options) than under learner control. However, Kinzie et. al (1987) did find differential effects between eighth-grade males and females: a three-way interaction among ability, type of control, and gender. The learner-control condition favored high-ability females and low-ability males.

Most of these studies, however, found extremely strong effects for general ability on achievement. Higher-ability students typically did much better than lower-ability students, regardless of type of control. This effect occurred among sixth- and seventh-grade students with CAI lessons on advertising concepts (Carrier & Williams, 1988; Klein & Keller; 1990); eighth-grade students learning about solar energy (Kinzie et. al, 1987; Kinzie et. al, 1988); ninth- and tenth-graders in geometry (Hannafin & Sullivan, 1995); and college students studying special education interventions (Schloss et. al, 1988) and instructional design principles (Schnackenberg & Sullivan, 1997).

One interesting finding emerging from several of the studies is that overall, both higher- and lower-ability students using learner control often outperformed students under program control (Carrier & Williams, 1988; Hannafin & Sullivan, 1995; Kinzie et. al, 1987; Kinzie et. al, 1988). However, in the remaining studies (Hannafin & Sullivan; 1996; Klein & Keller, 1990; McGrath, 1992; Schnackenberg & Sullivan, 1997) achievement under learner control and program control were essentially equal. This pattern of results contradicts findings from early learner-control studies (Carrier, Davidson, & Williams, 1985; Ross & Rakow, 1981) in which subjects under program control often outperformed subjects under learner control.

In light of results reported from recent research done in the area of learner control and learner ability, the questions of whether and how to incorporate learner control into CBI may need to be revisited. The posits that higher-ability students score better under learner control and lower-ability students score better under program control, may no longer hold true in the current technological age. This manifestation may be due in part to the changing nature of computers, computer software, and the advent of the Internet which occurred in the timeframe between earlier learner control/learner ability studies and more current research in this area. The newer forms of media have made learner control and free-access navigation more common features encountered by computer-users of all ability levels, thereby perhaps raising the overall competence in the appropriate use of learner control for many of the computer-using population.

As new forms of computer-based instruction are constantly evolving, continued research on the type of control, and perhaps on the amount of learner control, that is most effective with learners of differing ability levels seems justified. Research on the thought processes that lower- and higher-ability learners use to make learner control decisions may also yield information that is helpful to teachers, instructional designers, and researchers alike. Perhaps the most challenging responsibility of future research in the area of learner control and learner ability, in fact, all educational technology research, is in the to attempt to keep current with the rapidly changing nature of computer technology and the instructional implications that emerge from these new innovations.

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Distance Education: Analysis of Far- and Near-Site Interaction Patterns

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Abstract of the Study

Media Sensor is a device designed to sample and record various electrical impulses generated during a distance education session. These electrical impulses originate from a variety of visual sources at both the near and far ends of a session, as well as audio from both ends. From the changes of voltage recorded by the Media Sensor on either the visual or audio source, researchers are able to identify specific patterns and analyze the data by using a series of pattern analysis strategies to determine whether the records can present significant events occurred during a session. Accordingly, both the instruction and the classroom management of an instructor can be evaluated by the results of the pattern analysis.

In this study, the research team defined categories of classroom events by analyzing videotapes of several distance education sessions. The categories are: Teacher Talking (at near end), Interaction between Far-end and Near-end, Interaction at Near-end, and Unknown/Other. Furthermore, the team identified patterns by comparing the categories and the raw data recorded by the Media Sensor, testing the validity and reliability of the patterns, and applying them to construct the context within distance education.

Purpose of the Study

The purpose of this study was to explore the possibility of measuring distance education classes by using the Media Sensor.

Research Questions

The research questions for this study are:

- Can the Media Sensor identify pattern in the audio and video data recorded from distance education sessions?
- How to identify specific types of patterns?
- What correlation exists between the pattern and the actual instructional situation?
- How to predict instructional events by identifying specific pattern from data that the Media Sensor generates? Is it applicable to other types of distance education session?

Literature Review

Distance education is categorized into three generations according to Kaufman (cited in Bates, 1994, a single technology, multimedia, and two-way interactive technology. The first generation, single media, is mainly conducted by postal service based on paper. There is no interaction between students and the instructor. The second generation, multimedia, is represented by open university in UK. It is widely distributed, but still lacks interactions. The third generation, two-way interactive technology, includes video-conferencing and computer-mediated communication, and allows interactive communications. In the present paper, we will discuss distance education categorized as the third generation. One of the major concerns in distance education is on the learner, and on how instruction can effectively support or facilitate learning (Moore, 1990). There are various studies on different aspects of distance education. Classroom instruction process, students' satisfaction towards distance education, and interaction in distance education are frequently seen in distance education literature. For instance, on classroom instruction process and classroom management, Westbury and Bellack (1971) identified four general categories emerged in a classroom process. They elaborated on "Teaching Action" as one of the major instruction events in distance education sessions. Further more, they identified three teaching actions: "The actions of a teacher directed to the production of intellectual acts within the classroom, such as teacher talking, or making the students to talk; The actions of a teacher directed at making the students 'learningable', such as providing motivational factors; The actions of a teacher which are intended to contribute directly to the students' learning, such as providing practice of learned materials or techniques." (P. 243-245)

On student satisfaction towards instruction in distance education sessions, Pugh and Siantz (1995) found that "student satisfaction did improve over time." (P. 21) They also reported that "evidence from the observer comments and student comments tended to support that there was more interaction between the instructor and students and between students at the near end." (P. 22) This further supports that interaction is a major event that might lead to the level of student satisfaction or dissatisfaction.

On interaction in distance education, Moore (1990) presented three types of interaction: learner-content interaction, learner-instruction interaction, and learner-learner interaction. The author also discussed issues such as "what level of interaction is essential for effective learning, what is good interaction and how to achieve it, what the real-time interaction contribute, and whether it is worth the cost." Obviously, various types of interaction in distance education sessions are major categories of events that this study should identify and analyze.

There is no literature, however, on pattern analysis on the distance education session, and no study has been done on such device as media sensor since the device was first invented by Appelman. The study intended to fill in this gap.

A minor concern of this study is whether the tool used for audio and visual data recording -- the Media Sensor is effective in recording data. Kounin (1970) in his study on group management in classrooms listed out the deficiency of using human observer as data-gathering medium. This finding indirectly supports the use of mechanical device for an accurate and complete data analysis.

Significance of the Study

Findings from the study can be applied by other researchers in distance education. First, this study intends to reduce the time of observing each session in distance education by establishing a measurement of pattern to identify what is really happening in the session, without watching the video tapes. Second, this study can help other researchers to expand their study of evaluating instructor's pedagogy by examining outcomes, teaching styles, and classroom interaction. Third, this study provides same justification of the cost-effectiveness in using high-technology in distance education. For example, if there are only few interactions between far-end and near-end, it seems that we don't have to use such expensive technologies for distance education. Instead, we could just use a VCR to record the class, and then send the videotapes to students at remote sites.

Methodology

This study is to develop a measuring tool to predict what happens during a session in distance education without watching a video tape. The Media Sensor invented by Dr. Appelman, a professor at Indiana University, Bloomington, generates coded data sheet from video taped distance education sessions with time coding for both audio and video sources. The team analyzed the data to find specific patterns to identify significant events.

In order to identify the pattern of the audio and visual data collected from several distance education sessions taking place at the School of Education, Indiana University, Bloomington, an effective and efficient method of pattern identification, definition and analysis needed to be decided. Part of the literature review was conducted in search of such a critical tool for this study. Frick recommended the method of "Analysis of patterns in time (APT)" for analyzing observable phenomena so that the patterns of these phenomena can be recognized. APT measures temporal relations between variables by counting their occurrence. Frick found out that using proper sampling strategies could lead to the prediction of temporal patterns from APT results (Frick, 1990).

In the example of Classroom Observational Study, Frick used APT to investigate classroom events. "Highly trained observers collected observational data on paper-and-pencil coding forms. For illustration, only two classifications are discussed: available instruction (direct, nondirect, null), and student orientation to academic instruction (engaged, nonengaged, null). . . .The observers also coded the type of target student orientation to academic instruction that was occurring simultaneously with the type of available instruction." (1990, p.182)

After the data collection, grouping, and the calculation of its means, queries were made about these APT scores by researchers to look for recurring patterns or combinations of events in classroom. Researchers can also aggregate duration of certain kinds of events to see what proportion of the overall time they occupy. This data collection, grouping, and analysis method provides a foundation for the methodology of this study.

Media Sensor

The Media Sensor is a device that can capture both changes of brightness on a screen and voices from Far-end and Near-end sites. It is designed to sample and record the various electrical impulses generated during a distance education session. These electrical impulses originate from a variety of video and audio sources at both the near and far ends of the session. Video sources are sampled via photoelectric cells placed in a grid pattern over the screen of a television. The sensors for video are located in five areas on the screen (see Figure 1 below). Audio is sampled at the echo-canceller as "Far-end Receive" and "Near-end Send" sources (sensor 7 and 8 respectively, sensor 6 doesn't record any signal). Figure 2 is an example of the data sheet generated by Media Sensor.

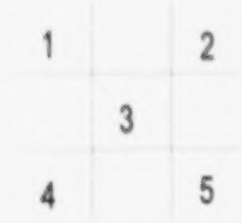

Figure 1: Sensor location on a TV screen (visual)

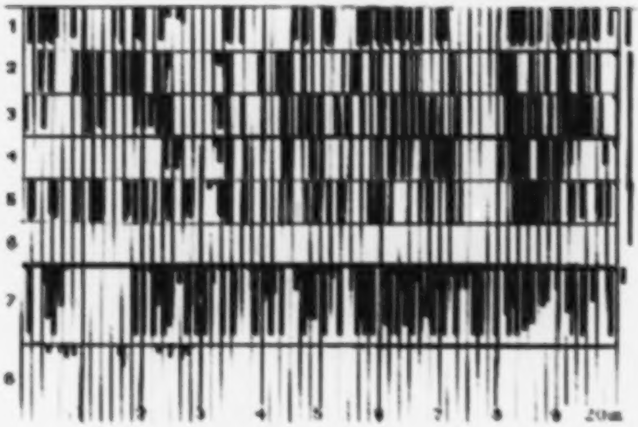

Figure 2: An example of data sheet

Data

Visual and audio sources pass through an analogue to digital converter and are sampled at various rates by the Media Sensor. While data sampling is occurring, records of each sample are sent to a computer as ASCII text for recording and analysis. Typical patterns of a data sheet is shown at the end of this Methodology section (Figure 5).

Pattern Definition Process

The analysis on the first two sessions generated the first version of the pattern definition. The team tested the accuracy of this definition in the analysis of the next two sessions. The result of the second round analysis generated information for the revision of the first pattern definition.

First Pattern Definition

Two video-taped sessions were provided to the team. The team listed several events that occurred in class by brainstorming and watching a 30- minute segment of a session on the videotape. Then, the team decided how to code those events on the data sheet, as shown below.

L = Lecturing
T = Teacher talking (at Near-end)
FS = Far-end student talking
NS = Near-end student talking
N = Noise
NA = Lack of audio/voice
I = Interaction
    FS → NS (between Far-end students and Near-end students)
    FS → NS
    FS → T (between Far-end students and teacher)
    NS → NS
    NS → T
M= Camera Movement
    T → S (switch between teacher and students) S → T
    P → D (switch between people and document) D → P
    S → S (switch between student and student) S → S
    ZI, ZO (zoom in, zoom out)

Although the team noticed that some of the above events were not predictable from the data sheet without knowing the instructional content, the team decided to observe two video taped sessions and code the entire session according to those categories. Then the team compared the coding results. The two persons who watched the same session checked with each other to detect any difference in the coding.

The next task was to identify patterns in order to predict events from data sheet. The team looked at the data sheet vertically from sector 1 through 8 and then separated voice parts (sector 7 and 8) from video parts (sector 1 through 5).

Throughout the entire data analysis process, the team defined Noise as single and short bars. The team understands that when counting the amount of time for interaction between near end students and the teacher, it is possible for the team to ignore some periods of teacher talking because it is hard to tell if the teacher is answering the questions, which is regarded as an interaction, or starting to lecture merely from looking at the data sheet.

The followings are our patterns for four categories, lecture, interaction between Near-end and Far-end, interaction at Near-end and Break.

Lecture:
    Audio: mostly blank, randomly single signal appears in section 8;
        Signals are in continuous chunks.
    Visual: More signals in sector 4 and 5;
        Sector 1 has almost no signal;
        Sector 2 has signals sporadically. It has more signals than sector 1;
        3 or 4 out of 5 sectors in 1-5 visual sectors have signals.
Interaction (Near- and Far-end):
    Audio: Signals appear in pair in sector 7 and sector 8.
    Visual: Signals appear 3 or 4 out of 5 sectors in 1-5 visual sectors.
Interaction (Near-end only)
    Audio: More blank among the signals in sector 7;
        No signal in sector 8.

Visual: 4 or 5 out of 5 sectors in 1-5 visual sectors have signals more dense than those in sector 3 through 5.

Break:

Visual: More dense than any other events in class time.

To test the validity of the patterns, the team gained two more video-taped sessions and paired up. Each pair looked at one data sheet separately without watching the videotape, and compared how much time was spent for each event in a session. Then, the same pair looks at another session on videotape, coded its data sheet and made comparison. Therefore, each pair conducted two analyses: (1) watched a video taped session and coded its data sheet during the observation; (2) coded events on another data sheet for the second session without watching the video tape.

The team also decided to mark colors on the data sheet to make it easy to differentiate and compare each other's coding on the categories of events. For example, pink marker was used for interaction among Near-end students. The team compared the coding results from data sheet only with the results from video tape observations to see if any agreement (validity) can be achieved. Refer to Table 2 on Page 18 for the results of video tape observation and prediction from data sheet.

As a result, the team obtained fairly good observer agreement on the total amount of time for each category calculated by persons who watched the video tape for coding. However, the team had a variety of results between the pair partners who predicted events from the data sheet only, and between the pair who coded only the data sheet and the pair who coded the data sheet by watching the videotape. This indicated that our patterns lack strong reliability and validity.

As a result of the data analysis at this phase, the team obtained advice from the instructor and decided to include Unknown as a category. The team also realized that the original definitions of patterns were subjective and vague. The team redefined the patterns, and created the decision making tree for pattern recognition. Our team obtained a new session on video tape taught by an instructor who had not appeared in the previous sessions. This time, all the team members predicted events from data sheet without watching the video tape, compared the total amount of time on each categories of events, and then watched the tape together to see if the coding results from data sheet matched what actually happened. The result was very positive, which showed to the team that the new definition of pattern was applicable at least to the analysis of this session.

Decision Making Tree

The team developed Decision Making Tree to present the pattern definition graphically. It can also be used as a method for data interpretation. The first Decision Making tree was developed after completing the first round of data analysis on the first two sessions. After the data analysis on the next two sessions, the team modified the first version of the Decision Making Tree. The following diagrams are the first and second versions of the Decision Making Tree.

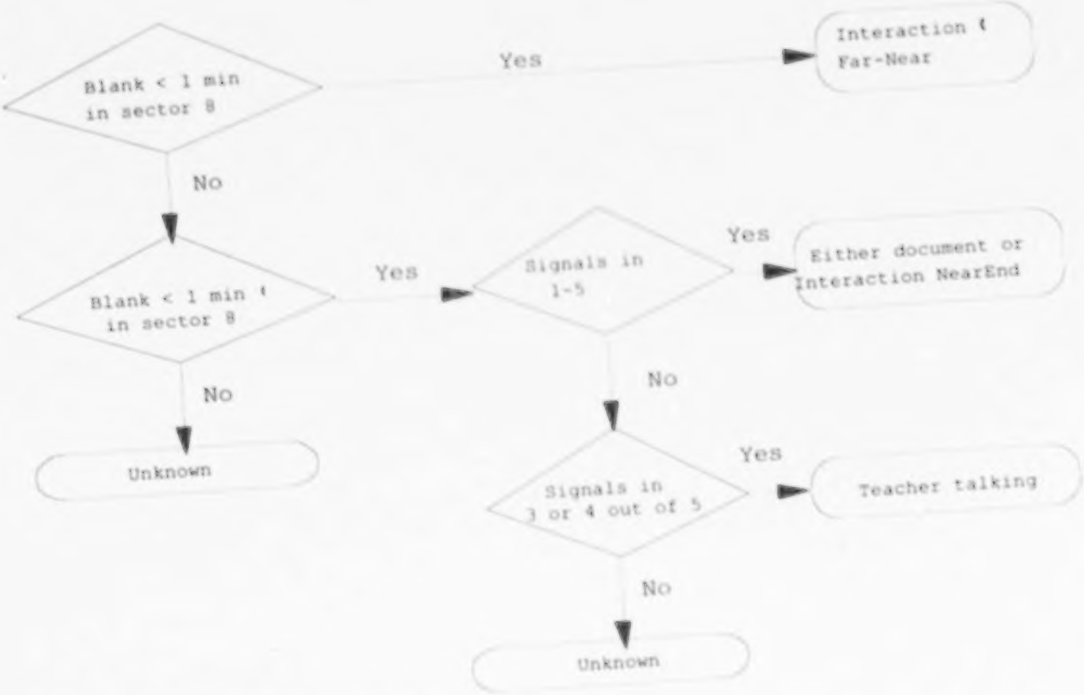
Blank < 1 min
in sector 8
Yes
Interaction (
Far-Near
No
Blank < 1 min (
in sector 8
Yes
Signals in
1-5
Yes
Either document or
Interaction NearEnd
No
Unknown
No
Signals in
3 or 4 out of 5
Yes
Teacher talking
No
Unknown

Figure 3: Decision Making Trees (version I)

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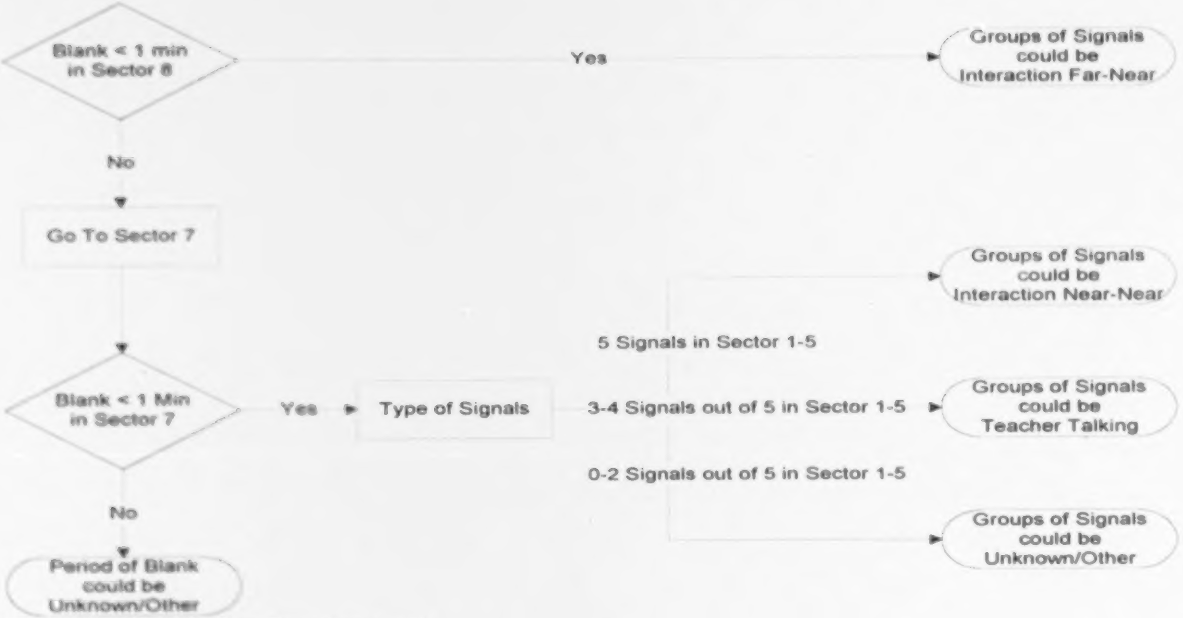

Blank < 1 min in Sector 8
Yes
Groups of Signals could be Interaction Far-Near
No
Go To Sector 7
Groups of Signals could be Interaction Near-Near
5 Signals in Sector 1-5
Blank < 1 Min in Sector 7
Yes
Type of Signals
3-4 Signals out of 5 in Sector 1-5
Groups of Signals could be Teacher Talking
0-2 Signals out of 5 in Sector 1-5
No
Groups of Signals could be Unknown/Other
Period of Blank could be Unknown/Other

Figure 4: Decision Making Trees (version II)

Final Pattern Definition

The followings are our final definition of events and patterns:

- Far-end interaction: dialogues between far-end and near-end people.

Patterns:

(1) In Sector 8, if there is a group of signals which have blanks among the signals that last longer than 1 minute, it is a far end interaction.

(2) In Sector 8, occasionally there are individual bars whose length is longer than 1/3 of the maximum length of a signal bar. These individual bars are also regarded as far end interactions. If a blank among single signals or chunks of signals is longer than 1 minute, go to Sector 7. If a blank in Sector 7 is smaller than 1 minute, it might be either teacher talking or near end interaction. If the blank is equal to or more than 1minute, the signal is regarded as Unknown/Others, which can be break, noise, technical problems (e.g., with sensors or recording devices, etc.).

- Near-end interaction: dialogues between people at near end.

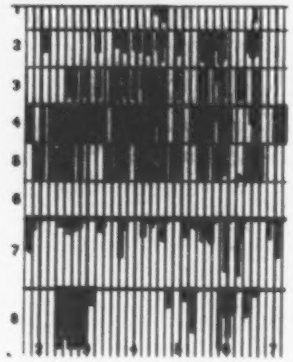
Patterns:

(1) Near-end interaction starts at the point when there are signals in each sector of sector 1-5 simultaneously, and ends when there is a signal or group of signals starts at Sector 8, which is a beginning of Far-end interaction.

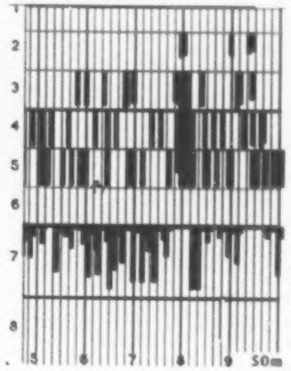
(2) Near-end interaction starts at the point when there are signals in each sector of sector 1-5 simultaneously, and ends when the same kinds of signals through sector 1-5 are identified. Thus, the interval between these two signal groups is regarded as the length of this near end interaction time.

- Teacher talking: teacher is either talking or lecturing.

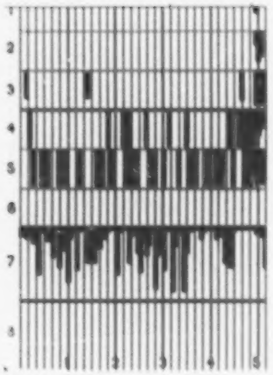
Patterns: If it is not a Near-end Interaction, and there are signals in 3 or 4 out of 5 sectors in sector 1- 5, it is a Teacher Talking or Lecturing.



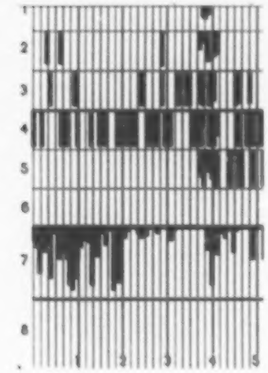
Far-end Interaction



Near-end Interaction



Teacher Talking



Unknown/Others

Research Results

According to the definition of pattern, the team studied other two distance education program, video 3 and video 4 (video 1 & 2 were the first two video sessions studied by the team). The results are shown in Table 1 and 2. D1 and D2 are the observers who predicted the instructional events by only looking at the data sheet; DV1 and DV2 are the observers who worked on both data sheet and video. The figures under D1 , D2, DV1 and DV2 are the amount of time each category of instructional event lasted in these two sessions.

Pearson correlation coefficient is calculated within a pair of observers and between the two pairs. The coefficient within a pair (D1 and D2, DV1 and DV2) can be regarded as an indicator of observer agreement, coefficient between the mean of the two pairs (the mean of D1 and D2 and the mean of DV1 and DV2) and is served as an indicator of validity.

	D1	D2	DV1	DV2
Teacher talking	5'08"	57'45"	20'40"	25'30"
Interaction (N)	5'10"	14'30"	12'00"	8'30"
Interaction (F)	14'20"	39'15"	61'00"	58'00"
Break	0	0	11'00"	11'00"
Unknown	86'52"	0	6'50"	9'55"
Observer agreement	-0.4176 p < .484		.9873 p < .002	
Validity	.1489 (p < .8111)			

Table 1: Observation on video 3 (111.5 minutes)

	D1	D2	DV1	DV2
Teacher talking	31'00"	61'00"	47'31"	63'08"
Interaction (N)	32'00"	4'30"	7'45"	9'20"
Interaction (F)	12'00"	11'20"	5'35"	6'42"
Break	0	0	3'10"	4'00'
Unknown	8"30"	7'10"	19'59"	0
Observer agreement	.5827 P < .0303		.8962 p < .04	
Validity	.947 (p < .015)			

Table 2: Observation on video 4 (84 minutes)

The observer agreement between the people who worked only on data sheet separately is -0.4176 ($p < .484$) in video 3 and .5827 ($p < .303$) in video 4, which means there is very little agreement when the two observers predicted instructional events by applying the pattern definition. The observer agreement between the people who viewed both video and data sheet is much higher, .9873 ($P < .002$) in video 3, and .8962 (.04) in video 4, which indicates there is very high agreement between those who looked at both video and data sheet.

The validity of the two observation is different from each other, .1489 ($p < .8111$) in video 3, and .947 ($p < .015$) in video 4. The validity of the first one is low comparing to the desired correlation, which is .60-.70. The second one is extremely high. However, according to the observers' comments, the defined pattern didn't work effectively, because there was so much uncertainty when the observers started to decided which category an event belonged to. Therefore the result could be a random guess. Besides, even though there is very good match between the total amount of time of each category of instructional events as predicated by D1/D2 and traced by DV1/DV2, those events observed by different observers did not match in terms of starting point and ending point of time, and often times these were totally different. Based on the statistics result and the observer's comments, the team changed the specifications of pattern definition. The team then applied the updated definition to a new distance education session, video 5 (Table 3).

	D1	D2	D3	D4
Teacher talking	8'00"	25'40""	21'53"	23'31"
Interaction (N)	17'00"	1'00"	2'40"	1'08"
Interaction (F)	52'40"	52'31"	52'10"	52'57"
Break	0	0	0	0
Unknown	2'00"	1'00"	2'24"	2'10"

Table 3: Observation on video 5 (80 minutes)

There were 4 observers working on video 5, D1, D2, D3, and D4. All observers analyzed the data sheet without viewing the video according to the updated definition of pattern and the decision making tree. Table 3 is the result of this analysis. Table 4 is the Pearson correlation coefficient between any two decoding. D2, D3 and D4 have very high correlation, .9962 between D2 and D3, .9986 between D2 and D4, .9991 between D3 and D4. The correlation between D1 and the rest ones, which is .8595 (D1 and D2), .8960 (D1 and D3) and .8768 (D1 and D4) respectively, is not as high as those between any two of D2, D3 and D4 because of some misunderstanding on the pattern definition of Near-end Interaction and Teacher Talking between this observer and the others. This explains why there is bigger difference in Teacher Talking time and Near-end Interaction time between D1 and the rest of the observers. Due to the time constraint, the team did not count the amount of time each event lasts in the video as the team did in video 4 and video 3. However, the team compared the analysis result with the video and found out almost all the events in video matched with the decoding results in terms of the categories of the evens and starting point and ending point of time of each event.

	D1	D2	D3	D4
D1	1.000 (.000)			
D2	.8595 (.062)	1.000 (.000)		
D3	.8960 (.040)	.9962 (.000)	1.000 (.000)	
D4	.8768 (.051)	.9986 (.000)	.9991 (.000)	1.000 (.000)

Table 4: Pearson correlation coefficient between pairs of observation on video 5

Conclusion /Discussion /Limitation

Conclusion

The team only checked one Distance Education session using the latest pattern definition and analysis method the team developed. The conclusion can be only applied to this session. It is concluded from this study that there are high correlation between the data generated by the Media Sensor and the instructional situation. The patterns are recognizable from the data sheet, and applicable in recognizing the instructional events without seeing the actual session.

Limitations:

- Validity of the study:

The team only studied five sessions, totally 8 hours and 50 minutes. Four out of these five sessions were taught by the same instructor to the same group of students. The definition of patterns obtained from and tested in these sessions might not be valid.

- Generalization:

Because of the small amount of sessions the team studied, and the unique teaching style each instructor has, the patterns identified from these sessions might not be applicable to other sessions. The team only viewed one session after the final revision to pattern definition. Thus, the conclusions we made are only applicable to this study.

- Content-free:

There is no way to differentiate the technical/equipment testing from instruction related interaction at the beginning of each session and interaction.

- The data depends on the experience and working style of the instructor who operates the camera. Different instructors could have different styles or habit when they operate the camera, and it affects the signals on the data sheet.

- The data record partly depends on the sensitivity of the sensors. There are some differences in data records when rearranging the position of the sensors.

- It is impossible to differentiate use of document camera and near-end interaction because both of them are accompanied by signals in all 5 video sectors.

- There are some technical problems when recording the signals.

One of the problems the team encountered was that it was uncertain whether the Media Sensor was reliable because there were some contradictions between the video tape session and the data record. Appelman explained that the electronic equipment could be more sensitive than human eyes, but on the other hand, if the background remains the same, media sensor can't detect the change even the camera moved. In this case, it happened when the team did not see any movement while watching the video, but there are signals on the data sheet, or vice versa.

Discussion

In the whole process, there are two stages: coding and decoding, as shown in Figure 5. Coding happens when patterns were defined from looking at the video and using the data sheet; decoding happens when applying these patterns to predict the actual situations . In either of coding and decoding process, some information is lost inevitably. There is also some distortion between the predicted patterns and the actual happenings when going through the coding and decoding stage. It is understandable that it is not 100 percent accurate to apply the pattern definition to predict the instructional events.

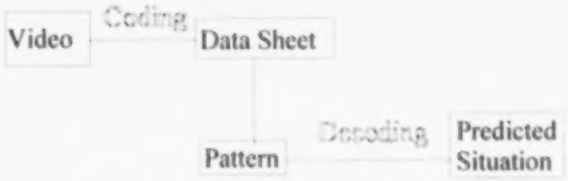


Figure 5: coding/decoding stages

To generate more accurate and applicable pattern, the team suggests:

- Establish a standard of camera movement, for example, the camera is only focusing on the relevant objects, with only the speaker appears on the camera.
- Revise the computer program depicting the data with smaller scale of time.

Future Research

Further validity studies are needed in which a wide spectrum of distance education sessions are coded by trained observers who will use the same pattern definition and pattern recognition method by viewing the data sheet generated by the Media Sensor.

If such validity is established, then the next step would be to see if the APT program can identify the patterns seen by human eyes when looking at the sessions. The APT program would be looking at some form of the raw data produced by the Media Sensor.

A third step is to specify, define and identify the pattern of different events in unknown part, such as break, noise, etc.

If these goals can be achieved, these patterns (from Media Sensor and APT computer program) can be correlated with other measures of distance education, such as effectiveness (e.g., student learning achievement), efficiency (e.g., cost-benefit analysis).

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Effects of Problem-Based, Networked Hypermedia, and Cooperative Strategies on Visual Literacy Instruction

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Abstract

This study examined the effects of varying instructional strategies on learning in emerging technology-based visual literacy instruction. The present study used a completely crossed 2 (organizational strategy) x 2 (delivery strategy) x 2 (management strategy) factorial design, post-test only control group design. Organizational strategies employed included criterion-referenced, objectivist instruction and problem-based, constructivist instruction. Delivery strategies employed included local, computer-based instruction and networked hypermedia-based (WWW) instruction. Management strategies implemented involved participation by individuals as well as cooperative dyads.

One hundred thirty-eight undergraduate education students were randomly assigned to eight treatment groups and a control group and received self-paced instructional treatments. Learners were assessed on performance (achievement), instructional efficiency, and efficiency of learner strategies employed (process efficiency).

Achievement measures for all treatment groups showed significantly higher levels of achievement when compared to the appended control group. Using multivariate and univariate analyses of variance, data were examined to determine what effect varying instructional strategies had on learning. Results indicated no statistically significant differences between any treatment groups. However, some strong data trends were observed. Data trends indicate further research should prove worthwhile in determining effects of instructional strategies on emerging technology-based instruction.

Introduction

Background and Theoretical Perspectives

Educators today debate the most appropriate instructional role of technology, particularly computer technology. The past ten years have seen the development of two trends with unprecedented effects on the course of educational technology: an increase in the number and types of technology resources available, and dramatic shifts in beliefs about the fundamental goals and strategies of education itself (Robyler, Edwards, & Havriluk, 1997). As the goals of education begin to change to reflect new social and educational needs, teaching strategies also change, and so do strategies for integrating technology into teaching and learning. One of the newer technologies available for instruction is the emerging information system called the Internet and the graphical-based access called the World Wide Web.

The effectiveness of newer interactive technology usage in instruction is open to debate. Moore, Myers, and Burton (1993) state that little actual research regarding the effectiveness of interactive technologies has been conducted and what has been conducted has limited value. Practitioners and researchers call for research that goes beyond traditional comparison studies. Grabowski and Pearson (1988), Slee (1989), Reeves (1986), Kozma (1991), and Moore *et al*(1993) have made calls for conducting research on the instructional strategies related to the specific attributes of the interactive medium. Hannafin (1992) identified the areas of constructivist models of teaching and acquiring knowledge, hypermedia, and cooperative teaching and learning as innovative instructional strategies that need to be addressed in emerging technology research.

Instructional Strategies

Gagné, Briggs, and Wager (1992) define instructional strategy as "...a plan for assisting the learners with their study efforts for each performance objective (p. 27)." Dick and Carey (1996) define instructional strategy as an

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overall plan of activities to achieve an instructional goal. Kemp, Morrison, and Ross (1994) differentiate instructional strategy from delivery strategy. Instructional strategy, they offer, prescribes sequences and methods of instruction to achieve an objective, and delivery strategy describes the general learning environment. Seels and Richey (1994) define instructional strategies as, "...specifications for selecting and sequencing events and activities within a lesson" (p. 31).

In contrast, Reigeluth (1983),Merrill (1983), and Reigeluth and Merrill (1978) identify three components or variables of instructional strategies: organizational strategies, delivery strategies, and management strategies. Although this instructional strategy lexicon is not widely used, it is this all-encompassing view of instructional strategies that is used as a framework for this study, as indicated in Table 1, below.

Organizational Strategies

Organizational strategies are those decisions the instructional designer makes when designing learning activities. Most important of these decisions is how the designer will assist learners to process new information and to process at a deeper level, producing meaningful learning. Most often, this is accomplished by the presentation and sequencing of content. How content will be presented and sequenced is most often determined in response to what type of learning is to take place, and how the designer believes an individual learns. Further examination of organizational strategies requires one to examine, at the most philosophical level, their belief whether or not knowledge exists independent of the learner. Which epistemological approach to learning a designer espouses will have great impact on the organizational strategy selected for use. At one end of the epistemological continuum is objectivism, while at the other is constructivism (Jonassen, 1991a; Jonassen, Wilson, Wang, & Grabinger, 1993).

Table 1. Instructional Strategy Matrix

	ORGANIZATIONAL STRATEGIES	DELIVERY STRATEGIES	MANAGEMENT STRATEGIES
Level A	Objectivist model of teaching/learning (Criterion-referenced Instruction)	Local Computer-based instruction	Individual learners
Level B (Hannafin, 1992)	Constructivist model of teaching/learning (Problem-based Learning)	Networked Hypermedia-based instruction	Cooperative learning pairs

Thede (1995) compared constructivist and objectivist frameworks in the design of computer-assisted instruction dealing with basic chemistry instruction for nursing students. The objectivist form of instruction was loosely criterion referenced, while the constructivist form was problem-based, but in a closed environment. Thede found subjects receiving the objectivist treatment scored significantly higher than the constructivist/ problem-based group on objectivistic post-test, particularly on the recall level questions. The objectivist group also scored higher on comprehension and application level questions, but not significantly so. The treatments varied widely in their presentation of what Thede termed identical content. In addition, no constructivist evaluation was given.

Savery and Duffy (1995) consider problem-based learning (PBL) to be one of the best exemplars of a constructivist learning environment. Very little research has yet been conducted on the effectiveness of problem-based learning as an instructional strategy (Gallagher, Stepian, & Rosenthal, 1992). Most of the research on PBL to date has focused on the adjustment of faculty to an innovative technique, (McAuley & Woodward, 1984; Moore-West & O'Donnell, 1985; Neame, 1982), student perception of the technique's usefulness (Blumberg & Daugherty, 1989), and the mechanisms of programmatic change (Thompson & Williams, 1985). Little, if any research has been conducted to date on the ways in which problem-based instruction affects student learning and cognition.

Many studies comparing discovery learning and expository learning have been reported. Because this comparison approximates somewhat the differences between constructivism and objectivism, these studies bear review. The results of these discovery-expository comparison studies are inconclusive. Andrews (1984), Hall and McCurdy (1990), Haukoos and Penick (1987), Lovelace and McKnight (1980), and Sugrue and Thomas (March, 1989) found in favor of discovery learning. In other studies, no significant differences were found by Canino and Cicchelli (1988), Elshout and Veenman (1992), Gesi, Massaro, and Cohen (1992), and Haukoos and Penick (1983).

Delivery Strategies

In the design of instruction, delivery strategies are those decisions affecting the way the information will be carried to the learner. Delivery strategies affect the selection of the instructional media that will be used to present the learning activities (Merrill, 1983). This study focuses on two delivery strategies: local computer-based instruction, and as indicated by Hannafin (1992), networked hypermedia based instruction on the World Wide Web.

Computer-Based Instruction

Several theories have been the basis for investigating the effect of computers in the teaching and learning process, including behaviorism, systems theory, and cognitive theory. Most of the techniques applied to the design and use of CBI can be traced to one of these theories (Simonson & Thompson, 1997).

In an attempt to design effective instruction, early media research compared one medium with another, typically comparing a new medium with traditional instruction. This type of research focused on finding the "best" medium of instruction for teaching students regardless of the learning situation. Overall, this research represented an effort to determine which medium would achieve the greatest with the greatest number of learners.

Although this research was prevalent, some researchers indicated that this type of investigation was inappropriate as a major research direction. For example, Allen (1959) stated that enough comparative effectiveness research had already been conducted, and that in part, research should focus on discovering the unique educational characteristics of each of the media of instruction. He reiterated this view in a later article (Allen, 1971) adding that such research should also include the relationship of media characteristics or attributes to the characteristics of the learner and the nature of the instructional task. A decade later, Clark (1983) also made a convincing case for research that emphasized instructional methods incorporated into media rather than studies aimed at finding the best medium for instruction. Instead of focusing on media, Clark (1975), Levie and Dickie (1973) and Saloman (1974, 1979) suggested that we study "attributes" of media and their influence on the way that information is processed in learning. Clark (1983) explained that it wasn't a particular media that offered advantages to the learning situation, but more a particular *attribute* of that medium that was not peculiar to only that medium, but shared by other media.

For the purpose of this study, this researcher has identified the following basic attribute categories for computer-based and networked hypermedia-based instruction (NHBI): access, content presentation, interactivity, and locus of control. Defining design attributes of CBI and NHBI are displayed in Table 2, below.

Table 2. Defining Attributes of CBI and NHBI.

Attribute	Computer-Based Instruction	Networked Hypermedia-Based Instruction
Access	One document open at a time	Many documents open at a time
	Program available locally	Program available globally
Content Presentation	No delay between screen presentations	Potentially lengthy delay in screen presentations due to downloading from Internet
	Content presented in small "chunks"	Content presented in scrolling fields or screens
	Linear, expository delivery of content	Organization of content determined by user selection of hypertext links
Interactivity	Interactivity programmed into lesson	Interactivity at learner's discretion (due to hyperlinking)
Locus of Control	Locus of control leans toward computer	Locus of control with learner

Networked Hypermedia-Based Instruction

An emerging type of technology-based instruction is networked hypermedia-based instruction (NHBI), commonly referred to as Web-based instruction. Hypermedia-based instruction is the application of hypermedia techniques to educational software (Heller, 1990). When hypermedia-assisted instruction or hypermedia-based instruction is delivered over a network, or more specifically, the Internet, it is called networked hypermedia-based instruction. Networked hypermedia-based instruction (NHBI) is referred to by a variety of terms and abbreviations, including WBT (Web-based training), WBI (Web-based instruction), and IBT (Internet-based training) (Driscoll, 1997).

NHBI is similar to traditional multimedia computer programs. In NHBI, learners engage in self-paced learning programs that use multimedia to communicate content. Interactions take place in the form of branching decisions that are controlled by either the learner or the program. These programs are most frequently used to transfer knowledge, build comprehension, and practice applying skills (Driscoll, 1997). The simplest form of NHBI programs are electronic books that feature hypertext and images. More sophisticated NHBI programs can include audio, video, and animation.

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NHBI differs from CBI in its capacity to use the Internet and provide communication links (Driscoll, 1997; Heller, 1990). NHBI's greatest advantage, therefore, is access to the multitude of resources available on the World Wide Web. The node and link structure allows that, in NHBI, instruction is not self-contained into one application package. Because of this, more than one document may be open at one time as the content may be spread across many network sites.

This node and link structure is one defining attribute of NHBI. A hypertext learning environment such as NHBI involves semantic nodes which are linked by an author for potential learner use. The semantic nodes are often the kind of word that might be indexed in an ordinary document. Instead of being listed at the rear of the document, such words are linked to other instances or other associated words in the same document or in other documents. In NHBI, these links can take the learner to another document located on another server anywhere in the world. By pointing and clicking on such words, the learner can travel across links to related sources of information. Other characteristics that distinguish NHBI from its precursor CBI are given in Table 1, above.

Little research has been done to date in the area of hypermedia in general. Jonassen (1991b) states, "to date, there is virtually no research that supports or rejects semantically structured hypertexts" (p. 93). Frey and Simonson (1990) report a study on cognitive style, perceptual modes, anxiety, attitude, and achievement in a hypermedia environment. However, hypermedia was simply used as a treatment vehicle and its relationship to other variables was not examined. Reeves and Harmon (1989) examined the relationship between a person's creativity and hypermedia, but found no significant relationship between the two variables. Jonassen (1991c) reports a study exploring graphical browser node arrangement in the form of an expert's semantic map. A control group provided with no structural information regarding nodes reported higher recall scores than treatment groups which were provided with descriptions of the nature of the links between nodes. The results of the study seem to indicate that hypermedia may not be as effective when highly structured.

Management Strategy/Task Structure

Management strategies are those decisions made in the design of instruction that affect the way the individual student will be helped to interact with the learning activities (Merrill, 1983). They are decisions about which organizational and delivery strategy components to use during the instructional process (Reigeluth, 1983). Management strategies involve motivational techniques and individualization schemes, among other implementation activities (Merrill, 1983). How learners will receive instruction, whether by lecture, individual seatwork, in small groups, and so on, is an example of management strategy. This study examines two management strategies: individual reception of instruction, and instruction delivered to cooperative groupings of two, or dyads.

Individualized Instruction

Instruction designed to meet the needs of the individual learner has long been a driving force in instructional design. Instructional design reminds us that regardless of how instruction might be delivered, be it to one learner, to twenty learners or to 400 learners, learning still occurs within individuals. Bloom (1984) maintains that one-to-one tutorial instruction is the most effective form and that an average student in a tutorial program achieves more than 98 percent of students in conventional classroom instruction. The history of instructional technology also indicates a strong commitment to individualized instruction which accommodates self-pacing, prescribes instructional methods according to learner characteristics, and permits content selection according to individual goals (Reiser, 1987). The rationale for individualization in technology-based instruction is intuitively appealing: people differ in ability, background, readiness, motivation, interest, and learning style and may therefore require different types and different paces of instruction to enhance their learning (Hooper, 1992a). Much evidence supports the belief that optimum learning takes place when the learner works at his or her own pace, is actively involved in the learning activities, and experiences success in learning (Kemp, Morrison, & Ross, 1994).

Cooperative Learning

In contrast, to increase the occurrence of active participation on the part of the learner, Slavin (1983) recommends structuring the learning environment to include other types of learner interactions, particularly student-student interaction, so as to provide more of an opportunity for students to take an active part in their learning. Cooperative task structures refer to those situations when group of two or more individuals can or must work together but may or may not receive rewards based on their group's performance. Virtually all cooperative groups incorporate a cooperative task structure (Hooper, 1992a) where group members work together toward a common task.

Research on cooperation has been conducted since the beginning of this century (see, Maller, 1929), although classroom research on practical cooperative methods began in the early 1970s. Despite the many studies done, the effects of cooperation on performance are still rather poorly understood (Slavin, 1983). Johnson and Johnson (1974), in a meta-analysis, found that cooperation is better than individualization or competition for all but the most concrete and repetitive tasks. Johnson, Maruyama, Johnson, Nelson, and Skon (1981) found strong evidence supporting cooperative incentive structures over individualistic or competitive incentive structures. In contrast, Michaels (1977) reviewed much of the same literature and concluded that competition is usually better than cooperation for most tasks.

The research seems more conclusive when examining cooperation and problem solving. As early as the 1930s, Thorndike (1938) considered the superiority of group to individual problem solving to have been proved. Studies that examined the reasons that groups did better on problem-solving tasks concluded that they did better simply because of the pooled problem-solving abilities of their members (Slavin, 1983). Faust (1959), Marquart (1955), and Ryack (1965) compared groups that really worked together to groups that groups that were randomly assigned to artificial groups. In all three studies, the real groups had higher achievement than the individuals, but not than the artificial groups, suggesting that the real groups had high scores not because of interaction, or motivation, but because if any individual in the group could solve the problem, than all members in the group would get credit for it, regardless of their participation or learning (Slavin, 1983).

Sufficient interaction is also a problem in computer-based instruction. Some believe that individualized instruction presented by computer creates "sterile" learning environments where learners interact only with the computer, apart from teachers and peers (Hannafin, Dalton, & Hooper, 1987). Dalton (1990) comments that, for many, "individualized" is synonymous with "isolated."

Research indicates that students who complete CBI in cooperative groups generally perform as well as students who work alone (Carrier & Sales, 1987; Shlechter, 1990) and often perform better (Dalton, Hooper, & Hannafin, 1989; Hooper, 1992b; Johnson, Johnson, & Stanne, 1985, 1986). Research supports cooperative learning as a means to improve achievement and attitudes in computer-based learning environments. Dalton and Hannafin (1987) found that learners working in pairs significantly outperformed learners working individually during a CAI lesson. In addition, learners working cooperatively on a CAI lesson produced a greater quality and quantity of daily work and demonstrated greater problem-solving skills than learners working individually or competitively (Johnson, Johnson, & Stanne, 1985).

Often, the effectiveness of cooperative learning is attributed to interaction among group members (Webb, 1989). Therefore, efforts should be made to promote interaction in cooperative learning situations. Hooper and Hannafin (1991) state one method to promote interaction involves increasing individual accountability, wherein each group member must demonstrate mastery of content in the instruction. This technique might also be used to isolate and remediate potential learning problems within the group and to provide an additional incentive to cooperate (Hooper, Ward, Hannafin, & Clark, 1989), as well as motivate more able group members to provide help and less able group members to invest sufficient mental effort to master instruction (Kerr, 1983; Kerr & Bruun, 1983).

Problem Statement

Hannafin's (1992) call for research for examining the effects of varying instructional strategies on technology-based instruction served as the basis for this study. The purpose of this study was to examine the effects of varying instructional strategies on learning in technology-based visual literacy instruction. Specifically, this study examined the effects of instructional organizational strategies, instructional delivery strategies, and instructional management strategies on learner performance in technology-based visual literacy instruction. Interaction effects of these instructional strategies on learner performance were also examined. Learning was assessed in three forms: achievement, instructional efficiency, and process efficiency. For the purpose of this study, instructional efficiency was operationally defined as the level of achievement (combined achievement score) divided by the amount of time spent on treatment. Process efficiency was operationally defined as a measure of the efficiency of the process of learning in terms of learner note-taking strategies employed in learning.

Methods

Subjects

Subjects in the present study consisted of 138 volunteers from a pre-service media methods course at a large midwestern university. The course is a required course for all teacher education students in the College of

Education. All subjects were undergraduate students, primarily sophomores and juniors. They ranged in age from 19 to 46 with a mean age of 22.1 years. The gender makeup of the sample population was 34% male and 66% female. In addition, subjects represented a variety of intended major areas of study.

Materials

Materials consisted of four separate visual literacy instructional packages representing two levels of instructional organizational strategies and two levels of instructional delivery strategies: a criterion referenced local CBI lesson, a problem-based local CBI lesson, a criterion referenced NHBI lesson, and a problem-based NHBI lesson. Treatment materials were developed by a design team consisting of one CBI designer, one NHBI designer, and two content advisers/subject matter experts, one of which was the investigator. The investigator had three years teaching experience with this particular subject matter in the course which served as the subject pool. The second content adviser/subject matter expert was a faculty member in the college and the course supervisor with 15 years experience in the field.

Objectivist Criterion Referenced Treatments

The criterion-referenced modules loosely followed Gagné's (1968, 1985) recommended events of instruction. Prior to the commencement of the lesson, subjects were given a one page introduction to the lesson that informed them that there would later be a quiz on the content in the lesson. An introductory section attempted to capture the learner's attention by mentioning and showing familiar visual images. At the opening of each section of content, subjects were informed of the learning objectives for that section on screen. The information, or stimulus material was next presented, followed the learning hierarchy. To allow learners some control, some sequencing of content was permitted, but the menu selections on both the CBI and NHBI versions were arranged in a suggested hierarchy as portrayed by a vertical screen menu. When faced with a vertical menu, subjects tend to select menu options in a top to bottom order. On-screen questions allowed learners to practice the new content. General feedback on the correct response was provided on screen for learners.

Constructivist, Problem-Based Treatments

The problem-based treatments were identical in content to the criterion referenced treatments. The differences included visual portrayal of menu selections on the local CBI treatments, no advising the subject of performance objectives, and the direction the subject received prior to commencing the lesson. The menu screen of the local CBI problem-based treatment package was arranged in a chevron shape that implied no inherent order of the content. This was done to encourage the subject to explore topics in order of interest or need to solve the problem presented, and to avoid imposing a hierarchical order of content on the learner. Due to limited options for presenting linked lists, the NHBI problem-based version of the module used a bulleted menu list identical to that used in the criterion-referenced NHBI module.

Learners were not informed of the instructional objectives prior to the presentation of content. This was done to allow learners to construct their own schemas for the content, rather than have an order imposed by the learning objectives. Instead, learners were presented with a teaching-related problem much like one that they would face in the real world. Learners were informed that they must create a poster and an overhead transparency to help them teach an instructional design topic that they had been developing. Learners were also informed that they would need to use the media developed in a teaching demonstration to their peer class. It was recommended that learners familiarize themselves with visual literacy concepts to aid them in their media development. No further explanation was given.

Local Computer-Based Instructional Treatments

The computer -based instructional program was developed using Authorware© on Macintosh personal computers. Every attempt was made to adhere to recommended screen design guidelines as given in Alessi and Trollip (1991) and Schwier and Misanchuk (1994).

The program included an optional introductory section on how to navigate through the program with the use of iconic buttons. This section was made optional so as not to bore the more technologically competent user. However, the design team felt that including these directions might facilitate comfort in the novice user, thereby focusing their attention on the content, rather than the distraction of operating the program.

The locus of control rested largely with the program in terms of content presentation. Learners were allowed to control the sequencing of content through menu selection. Once a learner was within a content section, however, they had only the option of proceeding to the next screen in the sequence, backing-up to the preceding screen, or returning to the menu screen.

In all but a few instances, the learner controlled the pace of screen presentation. However, there were instances when the program controlled the revelation of text on a screen in order to draw the learner's attention to specific points within that section of content. Text was never removed from the screen without the learner pressing the forward button; instead text was "dimmed" on revelation screens to cue the learner to look at new, appearing information.

The amount of content presented on each screen was kept to a limit of one idea or content "chunk" per screen. A total of 218 screens make up the criterion referenced CBI program, while 212 screens make up the problem-based package (less screens due to the lack of objective presentation). In order to keep the length of the program under one hour, opportunities for learner practice were limited. At the end of several sections, however, learners were asked thought provoking questions in text and visual formats. As visual literacy is a highly visual topic, an effort was made to include as many visual representations as possible. The final CBI package included 162 scanned images, clip art images, and hand-drawn graphics. All images and artwork included in the program were copyright-free. All content, information, and practice questions were contained in the CBI program. No outside materials besides the introduction page were made available to the students.

Networked Hypermedia-Based WWW Treatments

The networked hypermedia based instructional program was developed using identical text and images from the CBI version. Text and images were copied and formatted into HTML documents. As screen design guidelines for Web-based documents are lacking, attempts were made to make the pages as user-friendly as possible.

No introductory section on how to navigate through the program was included, as learners had previously studied navigation on the WWW. Learners were reminded on their introduction pages that links were presented in an alternate color to non-linked text, and that clicking on a link would take them to additional information on the topic. The NHBI version of the lesson consisted of 21 separate HTML page documents. The 21 pages included 53 links: nine links connecting to another area of the same page; 38 links connecting to a different page within the lesson, and six links connecting to sites external to the lesson.

The locus of control rested largely with the learner in terms of content presentation. Learners were allowed to control the sequencing of content through a list of links. The Web pages were planned to be used with a browser such as Netscape Navigator© or Microsoft Explorer©, that in addition to links, would allow the user to back up to all previously viewed screens in any order.

The learner controlled the pace of screen presentation through the use of scrolling pages. Revelation was not an option in the design of the Web pages, and so was not included. Text was never removed from the screen without the learner scrolling. For most of the sections of content, all content for that section was contained in one scrolling page. Sub-menu level lists linked the user to separate pages for design elements and design principles.

The final NHBI package included all 162 scanned images, clip art images, and hand-drawn graphics that were included in the local CBI package. However, many of the images were reduced to smaller sizes so as to reduce delays caused by downloading large image files from the Internet.

The HTML documents were loaded onto a Macintosh server. The Web pages were accessible from any type of personal computer with Internet access (Macintosh or PC). The server was tested to ascertain the number of users or "hits" it could accommodate at one time. It was determined that the upper limit of access was twelve simultaneous users, which was deemed acceptable for the size of the treatment groups in this study. For the purposes of this study, the Web pages were placed on the server only during treatment runs (so as to control exposure to subjects assigned to NHBI groups with Internet access outside the treatment time frame). All content, information, and practice questions were contained in the NHBI program. In addition, five pointer links were included to sites relating to visual literacy elsewhere on the Internet. Users were familiar with performing searches on the Internet, so additional information could be sought at the learner's discretion.

Dependent Measures

Learners were assessed on their achievement, instructional efficiency, and process efficiency. Achievement for this study was a combined score of a 30-item objective post-test and a 15-item checklist of the application of visual literacy concepts to learner generated visual media.

Achievement Objective Assessment

The achievement posttest was designed and produced by the researcher. Based on the instructional content of the visual literacy lesson, the instrument measured the knowledge gained by participants during their use of the instructional materials. The same test was given to all treatment groups and to the appended control group. The instrument was administered to participants two weeks after exposure to the treatments in order to measure long-term retention of knowledge.

The instrument covered all sections of the visual literacy content and was composed of 30 multiple choice questions with four possible answers to each question. The first 25 questions were entirely text-based, while the remaining five questions asked the learner to examine or interpret a given visual in order to generate a response. Items were written by the researcher based on the instructional objectives set forth in the instructional design. A typical item included on the instrument was: "Age, gender, race, and past experiences are examples of a) visual filters; b) socioeconomic filters; c) cultural filters; d) personal filters." The instrument was intended to serve as an objectivistic measure of achievement.

The content validity of the instrument was checked through the inspection of questions by subject matter experts in the field of visual literacy who were asked to check for overall content and accuracy. Using data obtained during the study, the instrument was examined for internal consistency. After examining the intercorrelations of item score and total score on the objective assessment instrument, six questions were dropped due to low correlates. Reliability of the remaining 22-item showed a Cronbach's coefficient alpha of 0.65 (n items = 22).

Achievement Application Assessment

Jonassen (1992) recommends for constructivistic learning that more goal-free evaluation methods be used and that it is higher order thinking skills that should be assessed. In response to this, a second achievement assessment instrument was designed and produced by the researcher. This second instrument, was designed to measure the application of visual literacy concepts and design principles, rather than simple recall. This application assessment was based on the instructional content of the visual literacy lesson to measure the knowledge gained and applied by participants after their use of the instructional materials. The same assessment was performed on all treatment groups . Participants were given two weeks after treatment to produce an instructional poster and an overhead transparency. The instrument assessed participant production in order to measure application of visual literacy knowledge.

The instrument covered all sections of the visual literacy content and was composed of 15 items or categories with five possible ratings in each category (none, poor, moderate, good, and excellent). A typical item for rating on the application assessment was: "Apparent eye path (use of COZULST layout)". The instrument was intended to serve as a constructivist measure of achievement.

As with the objective assessment of achievement instrument, the content validity of the application instrument was also checked through the inspection of categories by subject matter experts in the field of visual literacy who were asked to check the instrument for overall content and accuracy. Using data obtained during the study, the reliability of the fifteen item constructivist checklist which was applied to the subject-generated poster and overhead transparency yielded a Cronbach's coefficient alpha of 0.95 (n items = 30).

Combined Achievement Measure

As a variable with low reliability may include errors of measurement which may attenuate *F* ratios and generally confound interpretations of experimental effects, Pruzek (1971) recommends combining highly similar measures. In keeping with this recommendation, the 22-item pencil and paper objective measure and the two applications (one for each the poster and the overhead transparency) of the 15-item checklist were treated as a combined achievement score. For the 113 subjects, the internal consistency of the combined achievement measure calculated a Cronbach alpha of 0.93 (n items = 52).

Instructional Efficiency

Instructional efficiency was defined as the combined achievement post-test scores divided by the time required to complete the lesson. Units for this measure were given as score per minute.

Process Efficiency

Process efficiency was operationally defined as a measure of the efficiency of the learner strategies (note-taking) employed during the instruction. Process efficiency is calculated as the total achievement score multiplied by time spent on treatment and divided by the quantity of notes taken (word count).

Procedure

All subjects in this study were randomly assigned by computer to one of eight treatment groups as part of the required curriculum of the course:

• **OLI:**	Objectivist (Criterion referenced) local CBI, individual;
• **OLC:**	Objectivist (Criterion referenced) local CBI, cooperative grouping;
• **OWI:**	Objectivist (Criterion referenced) Web-based (NHBI), individual;
• **OLC:**	Objectivist (Criterion referenced) Web-based (NHBI), cooperative grouping;
• **PLI:**	Constructivist (Problem-based) local CBI, individual;
• **PLC:**	Constructivist (Problem-based) local CBI, cooperative grouping;
• **PWI:**	Constructivist (Problem-based) Web-based (NHBI), individual; and
• **PWC:**	Constructivist (Problem-based) Web-based (NHBI), cooperative grouping.

Subjects experienced treatment during their individual class meetings. At the treatment session, subjects were directed to their assigned computer workstation, asked to complete a demographic questionnaire, and to read the introduction handout. Both the CBI package and the NHBI Web site were pre-loaded for the subject's convenience. Subjects assigned to cooperative groupings were directed to wait for their assigned partner to commence the treatment.

All subjects were supplied with a notebook in which to record notes for study purposes. Notebooks were encouraged as generative learning aids such as note taking and outlining require the learner to take an active and responsible role in the instruction/learning process (Jonassen, 1988; Wittrock, 1974). The notebook was intended to promote deeper processing of the content, and to keep subjects from simply scrolling through the lesson. The subject was instructed to record their start time and ending time on the cover of their notebook. Notebooks were collected after treatment, photocopied, and returned to the subject in the next class period.

Content review via computer required between 30 and 100 minutes and was, for the most part, completed during the regularly schedule 50 minute class period. Students voluntarily stayed after class time in order to complete the modules. After completion of the instructional treatment, subjects were dismissed. The subjects then had two weeks in which to produce their instructional media. Subject notebooks were returned so that they could use their notes for reference and study purposes. The treatment materials (CBI and NHBI packages) were not available for reference.

Two weeks after treatment, section instructors collected subject-created instructional media. At that time, each subject completed the 30-item objective achievement instrument during a regular class meeting. Completion of the in-class assessment instrument required approximately fifteen minutes.

Subject instructional media productions were digitally imaged for later assessment by the researcher and returned to the subjects for further course use. The researcher reviewed the digitally imaged media productions, using the application achievement instrument to assign each subject and application achievement score. Scoring of all measures was performed blind to treatment group assignment

In addition to the 138 subjects, and additional 15 subjects volunteered to serve as an appended control for the study. The 15 control subjects were students in the same course during a later semester. The appended control group, without the benefit of instruction, completed the objective measure and produced both a poster and an overhead transparency. The application measure checklist was again used to quantify the application of visual literacy concepts to the production of educational media. The appended control group served as test of the reliability of the instructional materials.

Experimental Design and Data Analysis

The present study primarily used a completely crossed 2 x 2 x 2 (2^3) factorial design, post-test only control group design with organizational strategy, delivery strategy, and management strategy as the independent variables. The first independent variable, organizational strategy, had two levels —a constructivist, problem-based approach to instruction and an objective oriented, criterion referenced approach to instruction. The second factor, delivery strategy, also had two levels— via local computer-based instruction and networked hypermedia-based instruction via the World Wide Web. The last independent variable, management strategy, was also measured at two levels of individualization schemes, individual subjects and subjects in cooperative groupings of two.

The dependent variables for this study included a combined score of two measures of achievement, a post-test, and an evaluation of the application of visual literacy principles to the design of two pieces of educational media (a poster and an overhead transparency). In addition, instructional efficiency as measured by total achievement divided by time spent on treatment was a second dependent variable. Process efficiency, a measure of the efficiency of the learner strategies (note-taking) employed during the instruction, was a final dependent variable. Process efficiency is calculated as the total achievement score multiplied by the quantity of notes taken (word count) and divided by the time spent on treatment. The factorial matrix used is portrayed visually in Figure 1.

		ORGANIZATIONAL STRATEGY			
		Objectivist		Problem-Based	
		MGMT STRATEGY		MGMT STRATEGY	
		Individual	Cooperative	Individual	Cooperative
DELIVERY STRATEGY	LCBI	OLI	OLC	PLI	PLC
	WWW	OWI	OWC	PWI	PWC

Figure 1. 2x2x2 Factorial Design of Independent Variables

The relationship between dependent variables was assessed by examining correlations between dependent variables and by examining scatter plots of dependent variable scores to assess the direction of any relationships. Preliminary data analysis for this study was accomplished through MANOVA procedures. MANOVA effects were followed with univariate analysis of variance procedures to determine effects of and interactive effects of the organizational strategies, delivery strategies, and management strategies on each of the three dependent variables.

Results

Relationship Between Dependent Variables

Intercorrelations were run between the dependent variables to determine the relationship between achievement, instructional efficiency, and process efficiency. The Pearson-Product Moment correlation coefficient of combined achievement scores and instructional efficiency, $r = 0.815$, shows a strong, direct relationship between the two variables. The Pearson Product Moment correlation coefficients between combined achievement and process efficiency, and between instructional efficiency and process efficiency, $r = 0.599$ and $r = 0.63$, respectively, show a moderate, direct relationship.

Scatter plots of the dependent variables were generated to visually inspect the relationship between dependent variables to ascertain any nonlinear or curvilinear relationships. The relationship between achievement and instructional efficiency was strong, linear, and positive. This is to be expected as instructional efficiency is the dividend of achievement divided by time spent on treatment. The relationship between achievement and process efficiency was moderate, positive, and somewhat linear. The relationship between instructional efficiency and process efficiency as moderate, positive, and again, somewhat linear.

Results Regarding Research Questions

Multivariate and univariate analyses of variance were used to analyze data. The multivariate analysis of variance addresses all main effects and interaction effects of the instructional strategies examined in this study on the dependent variables as a whole. In contrast, the univariate analyses of variance address the main effects and interaction effects of the instructional strategies examined in this study on each dependent measure individually.

Multivariate Analysis of Variance

As the three dependent variables are correlated and likely share a common conceptual meaning, a three-way multivariate analysis of variance was used to analyze the data. The principle advantage of such a multivariate procedure over the traditional univariate *F* tests is that it permits a test of the possible interactions among multiple dependent measures that cannot be evaluated if each dependent measure is tested in isolation (Huck, Cormier, & Bounds, 1974).

The Wilk's Lambda criterion for multivariate analysis showed there is no significant multivariate effect attributable to organizational strategy (F (3, 95) = 0.765, ps <0.52), delivery strategy (F (3, 95) = 0.2.271 ps <0.09), or management strategy (F (3, 95) = 0.940, ps <0.43). The multivariate effect for the interaction of organizational strategy and delivery strategy, F (3, 95) = 2.348, is not significant at ps < 0.08. In addition, the multivariate difference for the interaction between organizational strategy and management strategy, and delivery strategy and management strategy can be accounted for by chance alone (Fs = 1.32 and 0.43, ps < .27 and .73, respectively). Finally, the multivariate effect attributable to the interaction of all three factors, organizational strategy, delivery strategy, and management strategy, F (3, 95) = 1.619 is not significant at ps < 0.19. A summary of the multivariate F ratios appears in Table 3.

Table 3. Multivariate Analysis of Variance (MANOVA) of Achievement, Instructional Efficiency, and Process Efficiency by Organizational Strategy, Delivery Strategy, and Management Strategy

Source of Variance	df	λ	F ratio	Prob. of F
Organizational Strategy (OS)	3/95	0.976	0.765	0.517
Delivery Strategy (DS)	3/95	0.933	2.271	0.085
Management Strategy (MS)	3/95	0.971	0.940	0.425
OS x DS	3/95	0.931	2.348	0.078
OS x MS	3/95	0.960	1.315	0.274
DS x MS	3/95	0.987	0.427	0.734
OS x DS x MS	3/95	0.951	1.619	0.190

Univariate Analysis of Variance

Although the multivariate analysis of variance for all three dependent measures showed no significant main or interaction effects generated by the instructional strategies studied, the strong but not significant effect of delivery strategy on the dependent measures (F (3,95) = 2.27, ps <.09) as well as the similarly strong but not significant interaction effects between organizational strategy and delivery strategy (F (3, 95) = 2.35, ps <0.08) and the moderate interaction effect between organizational strategy, delivery strategy, and management strategy (F (3. 95) = 1.619, ps<0.20) merits additional examination. Means and standard deviations for dependent measures for all treatment groups are shown in Table 4.

Achievement

The univariate main effect of organizational strategy on achievement, F = 1.77, df = 1/97, although strong, was not significant at $p < 0.19$. Varying instructional organization strategies (criterion referenced instruction and problem based learning) showed no significant effect on achievement when learning from technology based visual literacy instruction. Although not significant, examination of the cell means in Table 4 shows that for all groups, those groups receiving the constructivist problem-based treatment consistently scored higher on combined achievement than did those groups receiving the objectivist, criterion-referenced treatment. The relationship between organizational strategy and achievement is shown in

The univariate main effect of delivery strategy on achievement, F = 0.07, df = 1/97, is not significant at $p < 0.79$. Varying instructional delivery strategies (local computer-based instruction (CBI) and networked hypermedia based (WWW) instruction (NHBI)) shows no significant effect on achievement when learning from technology based visual literacy instruction. Although not significant, examination of the cell means in Table 4 shows that for all groups, those groups receiving the networked hypermedia based instruction consistently scored higher on combined achievement than did those groups receiving the local computer-based treatment.

The univariate main effect of management strategy on achievement, F = 0.001, df = 1/97, is not significant at $p <$ 0.97. Varying instructional management strategies (individual and cooperative task structures) shows no significant effect on achievement when learning from technology based visual literacy instruction. Although the effect of management strategy on

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instructional efficiency is not significant, examination of the cell means in Table 4 shows that for all groups, the individual task structure groups consistently showed a higher achievement score than did the cooperative task structure groups.

Table 4. Cell Means and Standard Deviations Comparing Organizational Strategy, Delivery Strategy, and Management Strategy for Combined Achievement, Instructional Efficiency, and Process Efficiency

Dependent Variable: Combined Raw Achievement Score

		Objectivist			Problem-Based			Total
		Individual	Cooperative	Total	Individual	Cooperative	Total	
Local CBI	Mean	60.13	62.87	61.15	68.69	66.15	67.55	64.47
	SD	26.41	20.23	23.16	22.5	23.44	22.54	22.86
	n	15	15	30	16	13	29	59
NHBI	Mean	67.23	62.58	63.00	67.5	68.93	68.24	66.74
	SD	26.23	22.13	23.96	20.51	29.32	26.02	24.36
	n	13	12	25	14	15	29	54
Total	Mean	63.43	62.74	6.09	68.13	67.64	67.9	65.61
	SD	26.09	20.68	23.37	21.23	26.31	23.61	23.51
	n	28	27	55	30	28	58	113

Dependent Variable: Instructional Efficiency (score/min.)

		Objectivist			Problem-Based			Total
		Individual	Cooperative	Total	Individual	Cooperative	Total	
Local CBI	Mean	1.23	1.05	1.14	1.22	1.2	1.21	1.18
	SD	0.45	0.33	0.4	0.43	0.57	0.48	0.44
	n	15	15	30	16	13	29	59
NHBI	Mean	1.44	1.1	1.28	1.43	1.28	1.35	1.32
	SD	0.67	0.57	0.63	0.5	0.5	0.5	0.56
	n	13	12	25	14	15	29	59
Total	Mean	1.333	1.07	1.2	1.32	1.25	1.28	1.24
	SD	0.56	0.45	0.52	0.46	0.53	0.49	0.5
	n	28	27	55	30	28	58	113

Dependent Variable: Process Efficiency

		Objectivist			Problem-Based			Total
		Individual	Cooperative	Total	Individual	Cooperative	Total	
Local CBI	Mean	8.59	7.57	8.05	7.46	7.72	7.58	7.82
	SD	2.93	3.69	3.34	3.16	4.6	3.82	3.56
	n	13	15	28	15	13	28	56
NHBI	Mean	8.39	7.35	8.18	12.57	10.1	11.2	9.75
	SD	4.5	3.48	4.06	10.22	3.63	7.38	6.15
	n	13	11	24	12	14	26	50
Total	Mean	8.73	7.49	8.11	9.73	8.91	9.32	8.72
	SD	3.73	3.53	3.65	7.5	4.21	6.04	5.02
	n	26	26	52	27	27	54	106

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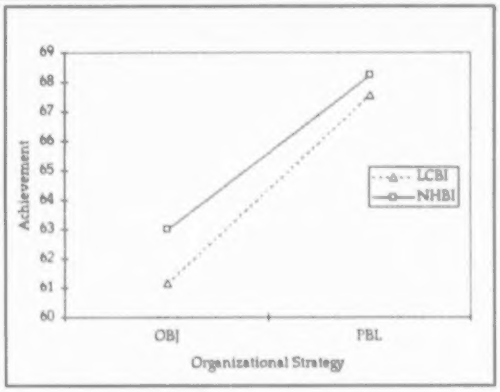

Figure 2. Combined Achievement Means by Organizational Strategy and Delivery Strategy

The univariate interaction effect of organizational strategy and delivery strategy, organizational strategy and management strategy, and delivery strategy and management strategy, show no significant effect on achievement. In addition, the interaction effect of organizational strategy, delivery strategy, and management strategy is also not significant ($F = 1.6$, $df = 1/97$, $p < 0.21$). The instructional strategies studied do not significantly interact during instruction to effect achievement when learning from technology based visual literacy instruction.

Instructional Efficiency

No significant main or interaction effects of organizational strategy, delivery strategy, or management strategy on instructional efficiency were indicated by the statistical analysis. Although the effects of organizational strategy, delivery strategy, and management strategy on instructional efficiency are not significant ($F = .1.67$, $df = 1/97$, $p < 0.2$; $F = 2.36$, $df = 1/97$, $p < 0.13$, and $F = .617$ $df = 1/97$, $p < 0.43$, respectively), examination of the cell means in Table 4 shows trends similar to those observed with the dependent measure, achievement. For all groups, those groups receiving the problem-based treatment consistently showed a higher level of instructional efficiency than did those groups receiving the objectivist treatment. In a similar vein, those groups receiving the networked hypermedia-based treatment consistently showed a higher level of instructional efficiency than did those groups receiving the local computer-based treatment. Finally, the individual task structure groups consistently showed a higher level of instructional efficiency than did the cooperative task structure groups.

Process Efficiency Results

No significant main or interaction effects of organizational strategy, delivery strategy, or management strategy on process efficiency were indicated by the statistical analysis. Although the effect of organizational strategy on process efficiency is not significant ($F = 1.77$, $df = 1/97$, $p < 0.19$), examination of the cell means in Table 4 shows that for all groups, those groups receiving the objectivist CBI and objectivist NHBI treatments performed similarly. In comparison, the mean process efficiency of those groups receiving the problem-based CBI decreased slightly from their objectivist counterparts. The mean process efficiency of the problem-based NHBI group increased strongly, indicating a probable drop in the number of notes taken with no corresponding drop in achievement score or time on treatment. The relationship between organizational strategy and instructional efficiency is shown in Figure 3.

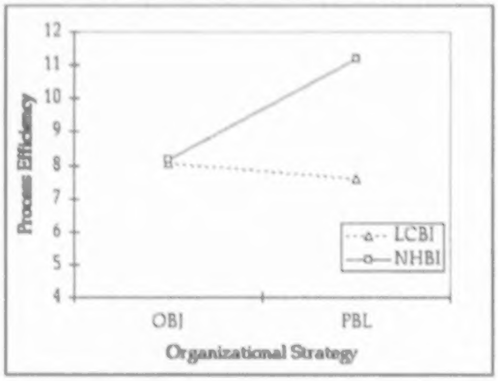

Figure 3. Process Efficiency Means by Organizational Strategy and Delivery Strategy

The effect of delivery strategy on process efficiency is not significant ($F = 3.22$, $df = 1/97$, $p < 0.08$). As this is the strongest F ratio of the entire study, this relationship bears some further examination. Examination of the cell means in Table 15 shows that for all groups, all groups receiving the local computer-based treatment and the groups receiving the objectivist networked hypermedia-based treatment consistently showed similar levels of process efficiency. Those groups receiving the problem-based networked hypermedia-based treatments showed considerably higher levels of process efficiency.

The effect of management strategy on process efficiency is also not significant ($F = .1.37$ $df = 1/97$, $p <$ 0..24). However, examination of the cell means in Table 4 shows that for all groups, the individual task structure groups consistently showed a higher level of process efficiency than did the cooperative task structure groups.

Discussion

Discussion of Research Findings by Organizational Strategy

MANOVA and ANOVA results indicated that there were no statistically significant differences in the amount of achievement, instructional efficiency, or processing efficiency associated with instructional organization strategies (criterion referenced instruction and problem based learning) when learning from technology based visual literacy instruction. Interesting trends, however, were observed in the data associated with organizational strategy. Groups receiving the constructivist problem-based treatment consistently scored higher on combined achievement that did those groups receiving the objectivist, criterion-referenced treatment. The corresponding F statistic associated with the univariate main effect of organizational strategy on achievement, $F = 1.77$, df = 1/97, although not significant, is strong at $p < 0.19$.

Those groups receiving the problem-based treatment also consistently showed a higher level of instructional efficiency that did those groups receiving the objectivist treatment. This was not expected, as the problem-based treatment gave learners no recommended path to review content. However, they showed no increase in time which would have decreased their instructional efficiency.

A similar type of relationship is seen between organizational strategy and process efficiency. Groups receiving the objectivist CBI and objectivist NHBI treatments performed similarly. In comparison, the mean process efficiency of those groups receiving the problem-based CBI decreased slightly from their objectivist counterparts.

The mean process efficiency of the problem-based NHBI group increased strongly, indicating a probable drop in the number of notes taken with no corresponding drop in achievement score or time on treatment.

The design of treatments employing different organizational strategies was tightly controlled to maintain equivalent content and content organization. In other words, although some effort was made to make the objectivist, criterion-referenced treatment and the constructivist, problem-based treatment dissimilar, a strong effort was also made to ensure that any effect seen would not be due to a difference in the amount or nature of content received, a problem noted by Mielke (1968) in early media-based research. If these restrictions were loosened somewhat, thereby increasingly polarizing the treatments, more significant differences in the achievement, instructional efficiency, and process efficiency levels of the treatment groups might be observed.

Discussion of Research Findings by Delivery Strategy

MANOVA and ANOVA results indicated that there were no statistically significant differences in the amount of achievement, instructional efficiency, or processing efficiency associated with varying instructional delivery strategies (local computer-based instruction and networked hypermedia-based instruction) when learning from technology-based visual literacy instruction. It should be noted that of all the instructional strategies examined, delivery strategies showed the strongest effect on the dependent measures. The multivariate analysis of variance showed the main effect generated by delivery strategies on all dependent variables combined was strong, but not significant at F (3, 95) = 2.27, $ps < 0.09$.

The univariate main effect generated by delivery strategy on achievement was not strong at $F = 0.07$, df = 1/97, $p < 0.79$. Groups receiving the networked hypermedia-based treatment consistently showed a higher combined achievement score and showed a higher level of instructional efficiency than did those groups receiving the local computer-based treatment. This was not expected as the researcher assumed the networked hypermedia-based treatment would require greater time to access and download individual pages. In retrospect, the learners did not have to wait to move from one screen of chunked content to the next as they did with the local computer-based treatment, so this likely accounted for any decrease in time spent on the treatment, thus increasing instructional efficiency.

A similar type of relationship is seen between delivery strategy and process efficiency. Groups receiving the local computer-based treatment and the groups receiving the objectivist networked hypermedia-based treatment showed similar levels of process efficiency. Those groups receiving the problem-based networked hypermedia-based treatments showed considerably higher levels of process efficiency, indicating a possible interaction effect between organizational strategy and delivery strategy on process efficiency.

Although there are an increasing number of WWW-page design guides (see, for example, Apple Web Design Guide, 1996; Schwier & Misanchuk, 1996, February), little has been written giving recommendations or guidelines for creating instructionally efficient WWW pages. Indeed, much of educational use of the Internet has been archival in nature (lecture notes, slide shows, and visual representations) (Shotsberger, 1996). With no recommended instructional screen design guidelines, the design team sought to create instructionally effective Web pages, extrapolating several screen design guidelines from computer based instruction and balancing them with measures to decrease download time of pages and images within pages. Hannafin (1985) proposes that the more rapidly program segments are accessed, the more effective the instruction. In order to keep the level and nature of content presentation similar across treatments, it is likely that the design team did not take full advantage of the node and link structure of the Internet. This minimal levels of links available most likely also decreased the level of disorientation felt by subjects, as is often the case in Web-based learning (Tripp & Roby, 1990). In addition, visual images were presented in a smaller format than they were on the local CBI treatments in order to decrease download time. As was the case with organizational strategies, increased polarization of the delivery strategy treatments might result in more significant differences in the achievement, instructional efficiency, and process efficiency levels of the treatment groups.

Discussion of Research Findings by Management Strategy

MANOVA and ANOVA results indicated that there were no statistically significant differences in the amount of achievement, instructional efficiency, or processing efficiency associated with varying instructional management strategies (individual and cooperative task structures) when learning from technology-based visual literacy instruction. Groups receiving instruction in an individual task structure consistently showed only a slightly higher combined achievement score than did those groups receiving instruction in cooperative dyads. This supports earlier research by Carrier and Sales (1987) and Shlechter (1990) that found students who complete CBI in cooperative groupings generally perform as well as students who work alone.

In addition, those groups receiving instruction in individual task structures consistently showed a higher level of instructional efficiency that did those groups receiving instruction in cooperative dyads This is to be expected, as an interaction, meaningful or otherwise, would cause the cooperative groupings to spend more time on the instructional treatment, thereby decreasing instructional efficiency. Instructional efficiency was considerably lower for those groups receiving the objectivist instructional treatment in a cooperative task structure.

A similar type of relationship is seen between management strategy and process efficiency. Groups receiving instruction in individual task structures once again showed a higher level of process efficiency than those groups receiving instruction in cooperative dyads. Since the instructional efficiency was higher for groups receiving instruction individually, indicating they spent less time on the treatment, a higher level of process efficiency for the individual groups indicates that the individual groups took less notes than the cooperative dyads, resulting in a higher level of process efficiency.

Discussion of Research Findings by Interactions of Instructional Strategies

Of all the interaction combinations of instructional strategies possible, only organizational strategy and delivery strategy showed any potential of an interaction effect on any dependent variable.

The multivariate analysis of variance showed the interaction effect generated by organizational strategy and delivery strategy on all dependent variables combined was nearly significant at $F\ (3, 95) = 2.34$, $ps < 0.08$. Univariate analysis of variance showed the interaction effect generated by organizational strategy and delivery strategy on achievement to be not significant ($F = 0.15$, $df = 1, 97$. $p < 0.7$). Univariate analysis of variance showed the interaction effect generated by organizational strategy and delivery strategy on instructional efficiency also to be not significant ($F = 0.07$, $df = 1, 97$. $p < 0.79$).

In contrast, univariate analysis of variance showed the interaction effect generated by organizational strategy and delivery strategy on process efficiency to be nearly significant ($F = 3.26$ $df = 1, 97$. $p < 0.7$). Examining Figure 3, a visual display of process efficiency means by delivery strategy and organizational strategy, the interaction direction can be seen.

The relationship can be described as follows. Groups which received the objectivist treatment showed relatively the same level of process efficiency regardless of delivery strategy. Groups which received the objectivist, networked hypermedia-based treatment also demonstrated approximately the same level of process efficiency. The groups which received the problem-based, networked hypermedia based treatments, however, displayed substantially higher levels of process efficiency. Since instructional efficiency does not show a similar potential interaction effect, it can be surmised that the potential interaction effect is likely due to a decrease in the quantity of notes taken by these groups, with no accompanying decrease in achievement scores or change in the amount of time spent on treatment.

The reasoning for this potential interaction effect can only be hypothesized. One reason may be that as proposed by Borsook and Higginbotham-Wheat (1992, February), the node and link structure of networked hypermedia-based instruction may in some way mirror the linked structure of mental schema. Kearsley (1988) offers that hypertext or hypermedia systems like the World Wide Web, improve learning by focusing attention on the relationships between ideas rather than on isolated facts. The associations provided by the links in NHBI, Kearsley offers, should facilitate retrieval, concept formation, and comprehension. If this is the case, further exploration of the application of constructivist learning theory to the design of Web-based instruction is certainly called for.

Implications and Recommendations

These results indicate that instructional strategies may be an important variable in learning from technology-based instruction. However, further research is needed to determine which aspects of each type of instructional strategy effects learning in emerging technology-based instruction. In particular, the treatments used in this study need to be refined in order to increase the differences between factor levels, thus increasing the power of the test. In addition, additional variables need to be researched, including aptitude, self-directedness, and motivation.

Although this study offered no statistically significant results, it does open the door for many research paths. At the very least, the lack of effect between treatments indicate that alternative methods and technologies of teaching and learning, including constructivist learning, networked hypermedia-based instruction, and cooperative learning deserve additional study.

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Using the ARCS Model to Design Multimedia College Engineering Courses

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Abstract

The design and development of Computer-Based Instruction (CBI) is a complex process. This paper describes how one Wayne State University multimedia design team is applying Keller's ARCS Model to the entire process of design, development, and evaluation of multimedia courseware. The ARCS Model has been applied to the prototype module and is being incorporated into all present and future modular designs. The design team is working with faculty members from five universities to design and develop multimedia courseware for college engineering courses to be delivered at a National Science Foundation project located at a manufacturing facility. A brief summary of Keller's ARCS Model is presented. The primary emphasis of the article is the description of the CBI design process and resulting product design and features as they relate to the ARCS Model. Issues that continue to challenge the design team are presented in the conclusion.

Establishing an Innovative Engineering Education Program

Just as a well-designed building depends on having a solid foundation, so does an instructional product. Engineering education emphasizes technology and technological innovations. Multimedia Computer-Based Instruction (CBI) is a dynamic, interactive technology. Motivating students with relevancy in instruction increases their learning of theoretical concepts. Combining these three elements--engineering education, multimedia instruction, and relevancy in instruction--can have a significant impact on the way students learn to become engineers.

These simple but profound statements have driven the Greenfield Coalition for New Manufacturing Education in the establishment of a new paradigm for engineering education. Furthermore, it is the unique combination of these factors that was the primary impetus for using the ARCS Model to design multimedia college engineering courses.

Funded by the National Science Foundation in 1993, the Greenfield Coalition for New Manufacturing Education is comprised of five universities, six industry partners, and a private agency. The original commitment was to establish a virtual university at Detroit's Focus:HOPE's Center for Advanced Technologies (CAT), a private agency manufacturing facility originally funded primarily by the U.S. Department of Defense. The university partners (Wayne State University, University of Michigan, University of Detroit Mercy, Lawrence Technological University, and Lehigh University) are committed to providing top-quality engineering curricula; the industry partners (GM, Ford, EDS, Chrysler, Cincinnati Milacron, and Detroit Diesel) are committed to providing equipment, contracts, and advisors; and Focus:HOPE is committed to providing the manufacturing facility, the classrooms, and the candidates for the degree program. The 150 full-time workers in the facility are the students in the "virtual university." The delivery of credit-bearing engineering courses is being accomplished primarily through "Innovative Instructional Processes" (IIPs). Consequently, from the outset the coalition adopted the following goals:

1) Create accredited degree programs--an associate's and bachelor's degrees;
2) Ensure that students will obtain the planned degrees primarily via the coalition's instructional modules;
3) Change from a teacher-student system to a coach-learner approach;
4) Develop a curriculum that will be used not only by the coalition's college but also by the participating universities; and
5) Utilize CBI modules as an integral part of the educational foundation.

In addition, the faculty developers were challenged to incorporate manufacturing relevance into the modules.

In the first three years, the faculty members (25-30 developers) from the partner universities were awarded contracts and were asked to design and develop their proposed CBI modules using Authorware Professional©, an icon-based authoring program. Although most faculty developers were experts in their engineering fields, they were not instructional designers or multimedia programmers. Unfortunately, the faculty developers were not given consistent guidelines, standards, templates, or much of anything in the way of professional support for the design and development of the CBI. Some university faculty members made impressive efforts in their design and development projects. Others floundered, however. Consequently, the various modules were often little more than text-filled page-turners with sparse media, confusing navigation, and limited learner control or interaction. The faculty developers delivered these CBI modules along with their classroom instruction to the candidates at the CAT with varied levels of success.

Establishing a CBI Team to Design and Develop Multimedia Courseware

In October 1996, NSF reviewed the CBI modules and concluded that the Greenfield Coalition should centralize production to improve the "quality and quantity" of the modules. This meant that the entire design and development process would undergo significant changes. To accomplish this major shift, the coalition established a professional multimedia design team comprised of an instructional designer, programmer, and a media specialist. Within six months the team added a graphics designer, writer/editor, multimedia specialist, and second programmer.

A CBI structure, or a basic blueprint, was established as the template for lesson presentation. All elements of a lesson center on the core material, which may be a text, series of articles, CD-ROM or other existing body of knowledge. In essence, then, the new CBI modules would not attempt to contain the entire course, but the CBI modules would be connected to a designated core material and contain only key elements that are best delivered through multimedia. In this new structure, a basic module is defined as having three to five topics with matching learning objectives with 50 to 100 screens (including 3-5 screens for a self-check and 5-15 screens for a module assessment that has a test bank of questions). The student should be able to complete the lesson in 30 to 90 minutes. Each module contains an introduction, stated learning objectives, summary of the core material lesson, illustrations and examples, simulations or "what if" questions, self assessment and a module assessment. In addition, modules may be linked to external software programs.

The learner's activities are tracked by a Computer-Managed Instruction (CMI) system. The student logs on to the client-server system, selects a course from the curriculum, selects a module, then selects activities within the module. The tracking of the learner's log on and selection is accomplished through Solis Pathware©, a product of Macromedia.

Committing to an ISD Approach and a Fully-Featured Prototype

To ensure that the design process and the CBI structure would be implemented effectively, the coalition team made a commitment to (1) an ISD approach and (2) a fully featured CBI prototype.

- Commitment to an ISD approach. The team decided early on that established Instructional Systems Design models and tenets would be the foundation for design and development. The Dick and Carey Model (1996) was applied to the macro design of the entire CBI process. Keller's ARCS Model (Keller1987a; 1987b; 1987c; Keller & Kopp, 1987; Keller & Suzuki, 1988) was applied to the design of the program interface, screen layout, and the CBI lesson presentation and on-line assessment. Furthermore, the ARCS Model was applied to the product evaluation process.
- Commitment to a fully featured CBI prototype based on our CBI structure. This meant that the team would design a CBI structure that would fit all the knowledge areas in the engineering curriculum. Each module would have consistent screen design (menu bar, mapping area, font type and size, text and media placement); standard navigation with alternative navigation methods to emphasize user control; on-line access to information; appropriate use of multimedia (graphics, animation, video, sound, simulations); and ample learner interactions.

ARCS: The Motivational Theory and Model

A core tenet of traditional instructional design theory and practice is that design should be a systematic process (Gagné, 1985; Gagné, Briggs & Wager, 1988; Rothwell & Kazanas, 1992; Seels & Richey, 1994). Because of the acceptance of a systematic approach designers generally follow an ISD model, which not only describes and explains the design elements but also prescribes the required activities to achieve the desired objectives. Educators generally consider motivation a relevant component in both learning and instruction. In his article, "Motivation and Instructional Design: A Theoretical Perspective," Keller (1979) presents a theoretical framework for the inclusion of motivation in the theory and practice of instructional systems design. Keller (1979; 1983) claims that if motivation is to be applied effectively to instructional design, it should be based on solid motivation theory and a systematic process of instructional design. One of the key ingredients in the successful implementation of the newly established Greenfield Coalition process was to apply the ARCS Model to the design of multimedia college engineering courses.

Keller's ARCS Model of Motivational Design (Keller, 1987a; 1987b; 1987c) works with a traditional ISD model.(See Table 1.) The acronym ARCS refers to the four key elements of motivation: A, Attention; R, Relevance; C, Confidence; and S, Satisfaction.

Table 1. The Interface of Motivational and Instructional Design

Phase	Instructional Design Steps	Motivational Design Steps
Define	Pre-project analysis--project	
	Conduct task, job, or content analysis	
	Conduct instructional analysis	
	Identify audience entry behaviors	Conduct audience motivational analysis
	Write performance objectives and criterion measures	Write motivational objectives and criterion measures
Design	Design instructional sequences	Generate motivational strategies
	Instructional methods	Select strategies
		Integrate motivational and instructional strategies
Develop	Select or create instructional materials	Prepare motivational materials
		Enhance instructional materials
	Develop test for learning and performance	Develop test for motivation
Pilot	Implement with test population representatives	
	Conduct formative evaluation	
gaph97	Certify or revise	

Note. From "The systematic process of motivational design" by J.M. Keller, 1987, Performance and Instruction, 26, p. 7.

Most design models include the basic steps of (1) define, (2) design, (3) develop, (4) implement, and (5) evaluate. The ARCS Model combines the last two steps of implement and evaluation into one, "pilot." Others in the field support Keller's claim that the motivational model fits well with a traditional ISD model. For example, Okey and Santiago (1991) demonstrate the model's value by using it with Gagné's Events of Instruction and Dick and Carey's design model. Main (1993) also showed how the motivation model could be used effectively with a traditional design model. Each major category has three sub-categories to be analyzed for the development of appropriate motivational strategies. The process questions guide the designer's focus and selection of strategies. (See Table 2.)

Table 2. Motivational Categories of the ARCS Model

Categories & Sub-categories		Process Questions
Attention		
A.1.	Perceptual Arousal	• What can I do to capture their interest?
A.2.	Inquiry Arousal	• How can I stimulate an attitude of inquiry?
A.3.	Variability	• How can I maintain their attention?
Relevance		
R.1.	Goal Orientation	• How can I best meet my learner's needs?
R.2.	Motive Matching	• How and when can I provide my learners with appropriate choices, responsibilities, & influences?
R.3.	Familiarity	• How can I tie the instruction to the learner's experiences?
Confidence		
C.1.	Learning Requirements	• How can I assist in building a positive expectation for success?
C.2.	Success Opportunities	• How will the learning experience support or enhance the students' beliefs in their competence?
C.3.	Personal Control	• How will the learners clearly know their success is based on their efforts and abilities?
Satisfaction		
S.1.	Natural Consequences	• How can I provide meaningful opportunities for learners to use their newly acquired knowledge/skill?
S.2.	Positive Consequences	• What will provide reinforcement to the learner's successes?
S.3.	Equity	• How can I assist the students in anchoring a positive feeling about their accomplishments?

Note. From "The Systematic Process of Design, " by J.M. Keller, 1987, Performance and Instruction, 26, p. 2.

Applying the ARCS Model to the Design of Multimedia Engineering Courseware

To design and develop the CBI prototype, the Greenfield Coalition CBI design team worked with two professors from Wayne State University on a course in engineering economics. The resulting CBI screen design serves as a model for present and future courseware development. (See Figure 1.) The four elements of the ARCS Model, adult learning theory, and multimedia design were used to guide design decisions.

Attention

Attention, as Keller points out, is the first condition of motivation and a prerequisite for learning. He argues that it is not enough to gain the learner's attention, the "...real challenge is to sustain it, to produce a satisfactory level of attention throughout a period of instruction" (p. 3). Keller's (1987b) definition for attention is "capturing the interest of learners; stimulating the curiosity to learn" (p. 2).

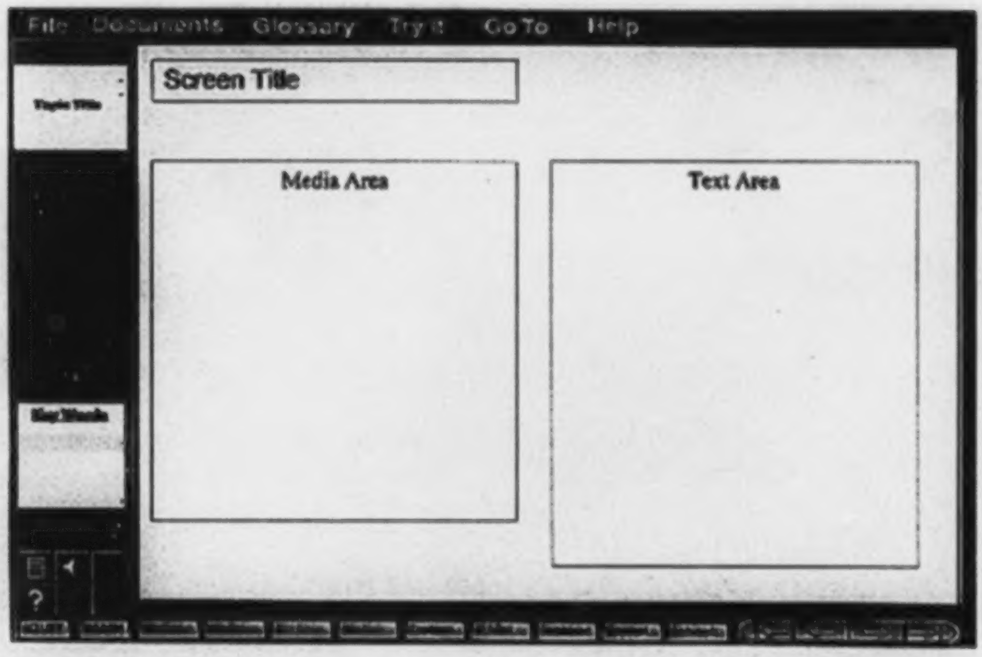
To gain and sustain the learner's attention, the design team incorporated multimedia into the Introduction; provided relevant graphics, video, audio, and animation throughout the lessons; and included ample learner interactions. Attention to the lesson is emphasized with the use of consistent placement of screen title, key words, objectives, summary, appropriate media and readable text. Although it may seem a simple accomplishment, restricting the text display area to ten or less lines of 16-pt. text on a screen was a major hurdle to overcome. Our experience with most professors is that they want to put as much text as possible on the screen. However, to catch and sustain the learner's attention, the text needs catch the reader's eye, be easily readable and understandable. This generally means shorter text elements. (See Figure 1.)

Relevance

Relevance, Keller (1987b) emphasizes, "is a powerful factor in determining what we are motivated to learn, or what we are willing to continue paying attention to after our attention has been aroused or restimulated" (p. 3). Relevance is defined as "meeting the personal needs/goals of the learner to effect a positive attitude" (p. 2). In a recent study with 100 college students, relevance was determined to be the most important motivational strategy (Means et al., 1997). The study investigated the comparative efficacy of intrinsic relevance of instruction and embedded relevance strategies as recommend by the ARCS Model of instruction. The researchers argue that "relevance strategies increase the meaningfulness of instruction by relating it to personal needs" (p. 7).

To increase relevance of the content to manufacturing, the CBI team designed in media (video, audio, animation, and graphics) that illustrated concepts and applications for the adult learner in the context of manufacturing. The faculty developers work closely with industry partners and representatives from Focus:HOPE to find relevant case studies, projects, and other experiential opportunities for incorporation into the module and the entire class. These elements are evident in the screen design shown in Figure 1.

Figure 1. Standard Screen Design for Multimedia Development



Confidence

Confidence, (Keller & Kopp, 1987) involves the learner's "positive expectancy for success" (p. 294). There are many factors that have an influence on a learner's confidence or expectancy for success, but the authors emphasize the complexity of the confidence factor in this statement: "Adults, like children, who are expected to learn a new skill need an opportunity to acquire and practice the skill under conditions where the psychological risks are reasonably low" (p. 294).

Providing learners the opportunity to practice and acquire new skills under low-risk conditions was a key component of the design. To build the learner's confidence, the design team concentrated on establishing three main

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elements: (1) a consistent, logical interface with ample user control; (2) embedded on-line support of the module; and (3) appropriate interactions.

At the top of the basic screen layout is the Menu Bar with six pull down menus: *File, Documents, and Glossary, Try It, Go To*, and *Help*. The menu bar was selected to imitate the familiar Windows presentation style. The menu options are explained below. (See Table 3.)

Table 3. Menu Bar Options

File	Click *File* to select *Quit, Find*, or *Return to Main Menu. Quit* is alternate navigation that takes the user to the Windows desktop, bypassing the Computer-Managed Instruction (CMI) home screen. *Quit* is also available in the Navigation bar at the bottom of the screen. *Find* allows the user to search for all instances of a word, phrase, or sentence. *Return to Main Menu* allows the user to return to the Computer Managed Instruction (CMI) home screen. *Return to Main Menu* is also available with the *Main* button in the Navigation bar at the bottom of the screen.
Documents	Click *Documents* to display a list of all electronic Portable Document Files (PDFs) that the student can print. The documents are PostScript files that are accessed through Adobe Acrobat Ó. Consistent throughout the courses are the following document types: Module Guide (outline of the lesson), list of key words and definitions for the module, list of objectives for both Module and Topic, and summary. Selected documents that the faculty include are: sample in-class test, list of formulas, and similar printable documents that would enhance their confidence in obtaining needed resource material for the class.
Glossary	Click *Glossary* to be taken to an application, which allows the user to look up all words, and definitions used in the Engineering Curriculum. This feature ties all the courses together. Definitions can be searched by the word or phrase or by the beginning letter of the word.
Try It	Click *Try It* for alternate navigation to select from the topic's interactions, practice exercises, and self-check opportunities. Students must select *Return to Main Menu* to access Self-Check, so the Self-Check will not be encountered as a student progresses through the lesson. These can also be accessed as the student progresses through the lesson. A Factor Calculator that allows the student to change variables for the formulas and view the changes in the cash flow diagram is available in the Engineering Economics modules.
Go To	Click *Go To* for a selection of all screen numbers and titles. This is alternate navigation that allows the user to highlight the screen he or she wants and go directly to it.
Help	Click *Help* to display these options regarding the program: *Program Tutorial, Quick Help*, and *Navigation Methods*.

The Menu Bar options are designed to increase the learner's access to embedded, on-line content information, alternate navigation choices, and guidance about the program's interface.

The left side of the screen is the mapping area, which contains advance organizers. Advance organizers alert the learner to key aspects of the lesson (Ausubel, 1968). At the top, directly under the *File* on the menu bar is the Topic Title of Module. This is displayed on each screen to focus the learner's attention on the section of the module he or she is in. Under the title are two hotspots: *Objectives* and *Summary*. A click on *Objectives* brings up a pop-up window of the topic's objectives. A click on *Summary* brings up the topic's last screen, which contains topic summary information. The *Key Words* list, which is in a box with a scroll bar, contains all the hypertext-words in the module. Highlight and click on a selected word to bring up the definition from a database. (These words are also available in the *Glossary* and *the Key Words* list in the *Documents* Pulldown Menu.)

Below the *Key Words* list are the *Tools* with buttons for: *Notetaker, Audio, Quick Help*, and a *Calculator*. Click on the *Quick Help* to access an interactive help screen of the screen layout areas and navigation buttons. Click on *Notetaker* to access a window that allows the learner to take notes about the topic and file the notes on a floppy disk. Click *Audio* to turn the audio on or off. Click the *Calculator* to access a scientific calculator that enables the learner to compute complex formulas. The *Tools* function pad is designed to ensure the learner has access to the tools needed for the completion of the lesson at all times.

At the bottom of the screen is the *Navigation Zone* that contains the buttons for navigation through the module. The first two buttons are *Quit* and *Main*. Click on *Quit* to return to the Windows desktop and exit the module. Click on *Main* to go back to the CMI home screen to select other activities in the module or to exit. The module's on-line activities (topics, self-checks, and assessment) and off-line activities (reading assignments, labs, case studies, etc.) are located at the Main Menu screen.

Three Application Link Navigation buttons are provided to the right of the *Main* button. *Link* buttons will only be available if the module is designed to have the student access an external program (e.g., Excel) during the lesson. A generic button space is reserved for special buttons (such as *Example* to bring up an illustration or example) that may be needed by different lessons. Interaction navigation is provided when an interaction is displayed. The buttons (*Return, Hint, Answer, and Reset*) will be highlighted for use. The last is the *Check* button that allows the user to access a self-check exercise. Once in the exercise, the button changes to *Score*, so the student can click on it to access his or her numerical score for the Self-Check. The fourth set contains *Standard Navigation* buttons, which allow the user to screen forward and back one screen at a time and to go all the way to the beginning and to the end of the topic.

The *Screen Layout* has four basic areas: *Screen Title, Screen Number, Media Area,* and *Text Area*. Each screen has a unique title and screen number that is designed to orient the learner to his or her place in the topic, which is an important instructional aid. This screen layout also is designed to focus the learner's attention and to build the learner's confidence because it increases the likelihood of the learner understanding the lesson progression and organization, and decreases the likelihood of the learner getting lost or disoriented (Park & Hannifin, 1993).

The *Media Area* is reserved for graphics, animation and video, and is generally placed at the left of the screen. The *Text Area* is at the right of the screen. The goal is to keep the text focused on one main point with approximately ten lines. Research shows that consistent screen layout with understandable organization increases the learner's learning (Hannafin, Hannafin, Hooper & Rieber, 1996).

Satisfaction

Satisfaction is a category that concentrates on helping learners feel positive about their achievement. This involves combining appropriate external rewards with the challenge of providing opportunities to achieve internal rewards in the areas of natural consequences, positive consequences, and equity (Keller & Kopp, 1987).

To ensure the learner's satisfaction with the interface and the presentation of the lesson, the CBI team emphasized user control with navigation options, helpful guidance and feedback, as well as equitable assessment. The learner is guided through practice exercises (interactions) and self-checks with access to more information, hints, and solutions. The learner may go through a module at his or her own pace and may take the self-check as many times as desired. At the end of a module, the learner takes a module assessment that is matched to the objectives and the self-checks. Since a Computer-Managed Instruction (CMI) program tracks the learner's activity, the learner can access his or her scores. Access to scores is designed in to help increase the learner's satisfaction with the lesson because it provides a sense of completion and an intrinsic reward.

Collaborating with Faculty, Using the ARCS Model to Guide Design and Development

The CBI design team meets with the faculty developers numerous times to plan the modules. The instructional designer is the primary contact with the faculty developers in the design and development of the courseware. The design team prepared and distributed a process handbook and a project notebook, containing electronic and paper copies of planning aids and storyboard templates. The faculty developers are advised to use the ARCS Model in the planning of instructional strategies and content presentation of the screens. Furthermore, a checklist is provided to help in the formative evaluation process.

Implementing the Process

Evaluation of the instructional product while it is in development, is critical to its successful completion. Therefore, the design team incorporated several stages and types of formative evaluation to ensure that the prototype incorporated the desired ARCS elements, followed best practices, and presented a functional, user friendly program interface. Formative evaluation in the form of reviews were conducted at various stages with five users, one content expert, one multimedia expert, and three instructional designers. Evaluation forms based on the ARCS model were used with the sample learners and instructional designers who reviewed the module prototype. Except for the users, all reviewers were experts in their field and were not associated with the design team's efforts. The data collected from these reviews were used to make significant changes to the prototype and all present and future CBI courseware designs will be based on this prototype.

The design team works collaboratively with the faculty developers (approximately 60 from five universities). A primary goal is to keep them informed of the basic building blocks in the new process. First, the design team conducted two workshops for this purpose in the past year. Second, the design team produced and distributed an extensive process handbook that explains the coalition's mission and goals, the design approach, the collaboration process, meeting agendas, and the consistent guidelines for the design and development of multimedia. The ARCS model is a key part of the design process handbook. Third, to ensure that the faculty developers have ample support as they plan and design their course, the design team developed over thirty planning aids that support the complex process of multimedia design.

Central to these planning aids are flow charts and storyboard templates. These serve as the blueprint for the interactive multimedia. The faculty team's PI (Principle Investigator) works with the instructional designer to lay out each screen of the CBI. The instructional designer, and other members of the team, as needed, meet with the developers as often as twice a month to confer on the design process, which requires a lot of feedback and revision. When final versions of the planning aids and storyboards are complete, the developers provide paper and electronic copies to the design team so programming can start.

In 1997, the CBI design team accomplished its first goal: the completion of a prototype and one module for one course. In addition, the design team began planning modules with six other faculty development teams. Two teams have completed storyboarding their first module. In October 1997, the prototype was presented to a NSF review team and given high ratings with a challenge to complete 25-30 modules in 1998. To accomplish this, the design team will double its staff, adding three instructional designers, one graphic designer, and three multimedia programmers. It will be a significant challenge to achieve this rate of production. Based on the positive reviews by NSF, the users, and external experts, the design team is confident that the established prototype and planning process that incorporate the ARCS Model (Attention, Relevance, Confidence, and Satisfaction) into the basic design will continue to provide a solid foundation on which to build.

Conclusion

The design and development of engineering courseware is a collaborative process, involving the Wayne State University Design Team, the university faculty developers, representatives from industry and Focus:HOPE. The prototype design, which is based on the ARCS Model Elements of Attention, Relevance, Confidence and Satisfaction, will be used in all future CBI course development. While still under development, the prototype was reviewed by students in the engineering program at Focus:HOPE as well as by experts in instructional design and multimedia. The data collected from the reviews led the team to make changes in the screen graphics, colors, button shapes and placement. The basic screen design and interface were given favorable reviews for their ease of navigation, on-line access to help, and high level of user control.

The challenges that face the design team and the faculty developers are many as we work together to use the ARCS Model in the design and development of computer-based college engineering courses. Meeting the production schedule is one of the most pressing challenges. However, the following challenges are also important:

- Designing computer-based lessons that are of sufficient challenge and depth for a college level course.
- Connecting the subject's conceptual theory to relevant applications.
- Providing sufficient problem-based learning opportunities, interaction, feedback, and on-line support of the lesson.
- Maximizing the possibilities of multimedia while adhering to sound learning theory.
- Staying current with new technology and translating the CBI modules to other instructional delivery media such as the World Wide Web.
- Determining the effectiveness of the CBI modules' instruction by evaluating the students' learning.

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An Investigation of PreK-12 Educators' Information Needs and Search Behaviors on the Internet

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Abstract

The Internet contains a vast array of educational resources, ranging from individual activities to whole curricula. This research study used content analyses and an electronic questionnaire to investigate how and why PreK-12 educators use information from the Internet for instructional design purposes in order to inform the design of an Internet-based system that provides one-stop, any-stop access to Internet-based educational materials. Results indicate that lesson plans are the most sought-after instructional resource on the Internet. The data also revealed that although most respondents use the Internet for instructional planning, they often consult several resources (print, electronic, and/or human) and use or adapt the information to meet their specific instructional needs.

Introduction

The number of educational resources available via the Internet-World Wide Web---valuable collections containing text, images and sounds, existing solely in electronic form---is increasing exponentially every day (Weibel, 1995). The organization of these materials is defined by the indexes provided by each of the various electronic locator services (e.g. Yahoo, Alta Vista) and independent online information providers [e.g. Educational Resource Information Clearinghouse (ERIC), Eisenhower National Clearinghouse, NASA]. But when the scope of resources becomes extensive, requiring richer records for each resource in order to improve search and retrieval, the usefulness of these Internet-based indexes becomes limited (Weibel, 1995).

If we think of each of these electronic collections as "virtual libraries," a teacher could currently visit any one library and retrieve some materials but then would have to go to another library and use different search strategies to find other materials and yet another for more or different materials. However, unlike today's physical library systems, these Internet-based virtual libraries have no overall organizing structure for information location and access. Extending our library metaphor, there is no "union catalog" (i.e. catalog of catalogs) on the Internet that allows users to go to one library and automatically access all related educational materials housed in other library collections. On the contrary, the Internet user must enter each virtual library (assuming an awareness of all relevant electronic collections and their locations), search for desired information, sift through the located resources to determine which are most relevant and useful, and then enter another virtual library, search and gather information again, enter another and search again, and so on. One potential result is information overload; for example, one participant in this study reported finding more than 30,000 lesson plans through Yahoo alone. This process is not only cumbersome and time-consuming, but also discouraging to the user, frequently causing him or her to prematurely end the search process without knowing if the most relevant and useful information has been located.

The Gateway to Educational Materials (GEM) Project, which teams a range of public and private information providers, national educational organizations, regional education laboratories, and state education departments, was funded through the ERIC Clearinghouse on Information and Technology by the U.S. Department of Education to develop a system for educators that provides "one-stop, any stop access" to the broad range of educational materials (e.g. teacher guides, lesson plans, curricula, primary documents) on the World Wide Web. GEM users can enter any of the educational databases within the GEM system (e.g. the AskERIC Virtual Library, Eisenhower National Clearinghouse, NSF's Math Forum), specify the parameters of their information need (e.g. "a reading curriculum for upper elementary gifted students," "tenth grade history lesson plans on the American colonial period"), receive a rich set of records describing all and only those resources that meet the specified criteria, and obtain quick and direct access to those resources.

Each resource in the GEM system is described by a simple, standardized metadata record, a set of descriptive terms that are "more informative than an index entry but less complete than a formal cataloging record" (Weibel, 1995, p.1), which automated tools are able to recognize and collect (Weibel, 1995). In order to define a metadata profile of search terms that simply yet sufficiently represents all of the electronic educational resources contained within GEM's "union catalog," research was conducted to explore how and what instructional resources are currently represented on the Internet, what types of information educators seek when designing their instruction, and how educators search for information electronically.

The specific research questions explored were:

(1) What are the most common types of instructional resources on the Internet and what are their essential elements?

(2) What information sources (including the Internet) do educators consult for instructional planning?

(3) When using the Internet for instructional planning, for what types of instructional information do educators search?

(4) How do educators rate their Internet searches in terms of ease, success, and satisfaction with the search process?

Methods

A variety of research methods was utilized to answer the above research questions. These methods were used to explore teachers' information-seeking behaviors when performing electronic information searches on the Internet and to identify the essential elements of instructional resources on the Internet. The methods include:

- • a content analysis of Internet-based instructional resources to determine their most common elements. As part of a course assignment, twenty-one graduate students at a northeastern university were asked to locate and retrieve a minimum of five instructional resources from the Internet-World Wide Web for analysis.
- • a content analysis of questions submitted to AskERIC, the Internet-based educational question-and-answer service of the ERIC Clearinghouse on Information & Technology, to explore the specific instruction-related information-seeking needs of educators using the Internet and the terms they use to describe those needs. An analysis of 1,995 questions submitted to the AskERIC service during July 1996 was performed to determine how and with what terms educators ask for information for instructional planning. The advantages of this method are that it (1) is an unobtrusive and naturalistic way to study user behavior and (2) limits bias due to reconstruction, post-hoc rationalization, or expectancy effect.
- • an electronic questionnaire, based on the data gathered from the content analyses, to determine how educators search for instructional information on the Internet and administered online through the AskERIC service. AskERIC users were selected because they were more likely to be (1) regular users of technology and (2) members of the targeted preK-12 educator audience. Although this data gathering technique was easy to administer and able to reach large numbers of potential respondents, there were disadvantages; e.g., due to the length of the questionnaire, many of the questions were necessarily brief; there was no way to elicit follow-up, clarifying information.

Results

(1) What are the most common types of instructional resources on the Internet and what are their essential elements?

Educational resources range in scope from the broadest curricula to the narrowest activities. Most instructional resources appear to fall under one of the following categories (Eby and Kujawa, 1994):

- curriculum guides or courses of study that may span several grade levels and subject areas (e.g. science, U.S. History). These may contain a number of:
    - units , thematic divisions within a semester or year-long curriculum (e.g. constellations, American Civil War). These may contain two or more:

- lesson plans, one- or two-session, organized learning experiences (e.g. the Big Dipper, the Battle of Bull Run). The narrowest type of educational resource may appear as part of a lesson plan or stand alone as an autonomous entity. These include:
    - learning resources (e.g. a reference book on constellations, a multimedia CD-ROM on the Civil War)
    - learning activities (e.g. making a mobile of a constellation, a field trip to a Civil War battleground)

From the original sample of 111 Web-based Internet resources, 13 were found to be duplicates and three were not considered instructional, leaving 95 resources for analysis. Of the 95 resources, there were 72 lesson plans (76%), 22 unit plans (23%), and one activity (1%). Although this sample was relatively small in comparison to the thousands of resources available on the Internet, it appears to be representative, indicating that lesson plans are among the most common type of instructional resource available on the Internet.

A content analysis of the 95 Web-based resources revealed 32 categories of common elements. The elements appeared either as separate and distinct elements or as elements embedded within other elements. Separate elements appearing in 90% or more of the resources were activities (95; 100%), materials (e.g. handout, textbook, video) (91; 96%), title (88; 93%), and purpose (e.g. instructional goals, learning objectives) (87; 92%). Elements embedded within other elements 90% or more of the time were instructional strategies (e.g. examples) (95; 100%), and topic (85; 90%) (see Table 1). Elements appearing in at least one-half of the resources were grade, subject area, and author (separate) and grouping (embedded). Most embedded elements were found within either title or activities.

In order to further explore the types of information important to educators, 1,995 questions submitted to AskERIC during July 1996 were retrieved and analyzed for relevance, resulting in a total of 161 relevant [related to pre-Kindergarten (preK) through Grade 12 instructional design] questions for content analysis.. PreK was included because of the common integration of preK classes into elementary schools throughout the U.S. (Riede, 1997). Data were analyzed by two independent coders with a .93 coefficient of reliability, deemed acceptable.

Each question was analyzed to determine what information was requested and what information was specified within it. Data analysis determined that, by far, the most frequently requested type of instructional information was the lesson (54; 33%) (see Figure 1). All other requested information (e.g. materials, activities, units) was included in less than 10% of all questions.

Element	Occurrence N(%)	Separate n (%)	Embedded n (%)	(Most Common Location)
activities	95 (100%)	95 (100%)	0 (0%)	
instruc. strategies	95 (100%)	0 (0%)	95 (100%)	activities
materials	91 (96%)	70 (77%)	21 (23%)	activities
title	88 (93%)	88 (100%)	0 (0%)	
purpose	88 (93%)	85 (98%)	2 (2%)	title/summary
topic	85 (90%)	16 (19%)	69 (81%)	title
grade	75 (79%)	61 (81%)	14 (19%)	title
subject area	64 (67%)	47 (74%)	17 (26%)	title
grouping	56 (59%)	8 (14%)	48 (86%)	activities
author	56 (59%)	56 (100%)	0 (0%)	
date	43 (45%)	26 (61%)	17 (39%)	copyright statement
content descrip.	42 (44%)	19 (45%)	23 (55%)	activities
author address	38 (40%)	38 (100%)	0 (0%)	
assessment	37 (39%)	28 (76%)	9 (24%)	forms
time	32 (34%)	20 (63%)	12 (37%)	activities
enrichment	32 (34%)	30 (94%)	2 (6%)	activities
publisher	30 (32%)	15 (50%)	15 (50%)	copyright
add. resources	27 (28%)	25 (93%)	2 (6%)	activities
materials proced.	19 (20%)	6 (32%)	13 (68%)	activities/materials
copyright	15 (16%)	15 (100%)	0 (0%)	
source	13 (14%)	13 (100%)	0 (0%)	
forms	19 (10%)	19 (100%)	0 (0%)	
prerequisites	9 (10%)	9 (100%)	0 (0%)	
summary	8 (8%)	8 (100%)	0 (0%)	
other audiences	7 (7%)	7 (100%)	0 (0%)	
outline	7 (7%)	7 (100%)	0 (0%)	
location	7 (7%)	1 (14%)	6 (86%)	activities
instruc. style	5 (5%)	4 (80%)	1 (20%)	outline
teacher role	4 (4%)	4 (100%)	0 (0%)	
comments	3 (3%)	3 (100%)	0 (0%)	
season/weather	2 (2%)	0 (0%)	0 (100)	activities
author descrip.	2 (2%)	2 (100%)	0 (0%)	

Table 1. Total Occurrence, Separate and Embedded (with Common Location) Elements Found in Instructional Resources (N=95).

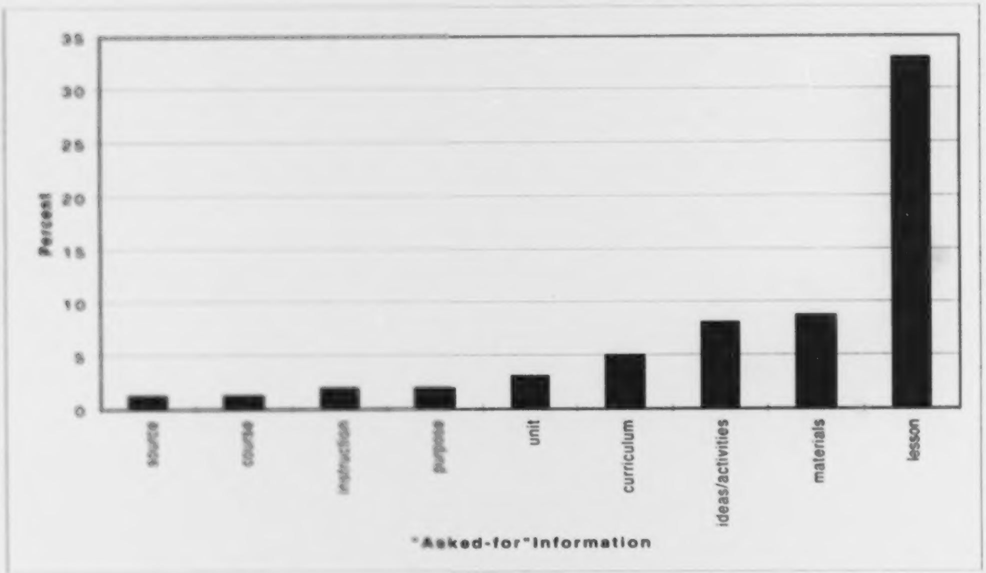

Figure 1. Requested Information in AskERIC Questions (N=161).

Data revealed that educators typically frame their queries in the context of a subject area, i.e. either a broad curriculum domain such as mathematics or science or a more specific subject such as algebra or ecology (74; 46%), grade range (e.g. middle school, primary) (69; 43%), and/or topic, i.e. more specific subject such as primary numbers or air pollution (57; 35%) (see Figure 2). A specified grade level was included within 39 (24%) of the AskERIC questions. All other specified elements were present in less than 20% of all queries.

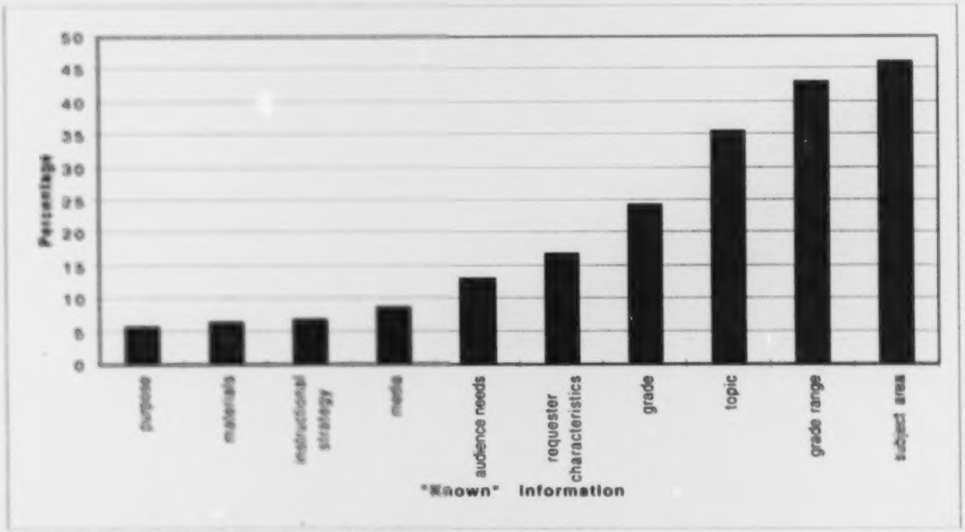

Figure 2. Specified Information in AskERIC Questions (N=161).

(2) What information sources (including the Internet) do educators consult for instructional planning?

A 32-item questionnaire consisting of 21 multiple-choice and Likert-type items and 11 open-ended questions was emailed to 2, 135 questioners who had used the AskERIC service during July and August 1996. A total of 283

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responses (13%) were returned; 23 were classified as invalid because the respondent was not directly involved with preK-12 instruction, leaving 260 questionnaires for analysis The low response rate was attributed to three potential causes: (1) the high number of "other" users of AskERIC (e.g. adult educators, school administrators, students) who were not the targeted respondents for this study, (2) some AskERIC users may have submitted more than one question to AskERIC during that time period and, therefore, would have received multiple questionnaires but only returned one, and (3) the difficulty for some participants to respond electronically due to inadequate hardware or limited access. Results where N<260 indicate missing responses.

Demographically, respondents (N=257) represent all types of community school districts: urban (72; 28%), suburban (92; 36%), and rural (81;31%), with 12 (5%) indicating they came from some combination (e.g. rural-suburban). In terms of years of instructional experience, more than one-half (145; 57%) of respondents (N=256) had more than 10 years of teaching experience, 56 (22%) had 6-10 years, 39 (15%) had been teaching from one and five years, and 16 (6%) had less than one year of teaching experience. The majority (N=244) were female (189; 77%), with 55 (24%) male. These statistics roughly parallel national demographic patterns of U.S. educators (NCES, 1996; 1997).

Respondents also represent the range of content areas of preK-12 instruction. Of the 249 respondents, 22 (9%) were from the math/science subjects; 31 (12%) were from the humanities (language arts, English, foreign languages, religion and philosophy, art); 16 (6%) represented the social sciences (economics, history, geography, civics, social studies); 72 (29%) taught all subjects (e.g. elementary, special education); 34 (14%) taught multiple subjects (i.e. two or more subjects, but not all subjects); and 74 (30%) were information technology educators (library media specialists, computer teachers) (see Figure 3). The over-representation of the latter category [e.g. library media specialists represent 2% of U.S. educators (NCES, 1996)] is most likely due to the bias of drawing the sample from the AskERIC user population which typically includes a large proportion of library media specialists and technology teachers.

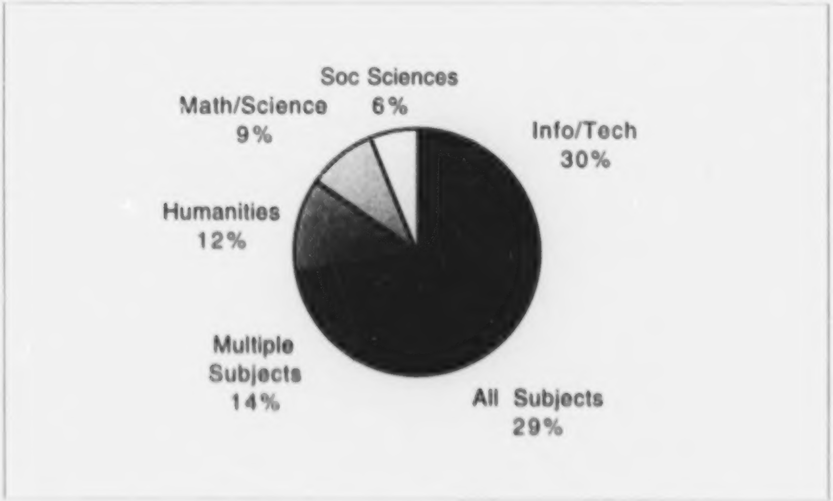

Figure 3. Content Areas Represented by Questionnaire Respondents (N=249).

Although an attempt was made to classify respondents by grade level categories (e.g. K-5, 9-12), it soon became apparent that it was not possible to create exclusive grade level clusters because of the wide variety of responses to this question. Some responses that illustrate this variety are: "K-12," "grades 5-8," "10-14 year olds," "grades 3, 5 and 8," "preK-K," "grades 6-12," and "grade 1."

Respondents were asked to rate thirteen information resources that typically contain information used for instructional design on a scale of 1(never used) to 5 (used very often). In general, the most commonly used resources appear to be print-based (journals & newsletters, K-12 textbooks, books/magazines), followed by workshops and electronic resources (Internet sites, databases). (see Table 2). When it comes to human sources, colleagues is the only resource ranked above 3.0.

Source	Ranking
journals/newsletters	3.81
K-12 textbooks	3.76
books/magazines	3.74
workshops	3.64
Internet sites	3.51
electronic databases	3.46
colleagues	3.03
librarians	2.97
experts	2.91
videos	2.70
bulletin boards/listservs	2.70
college textbooks	2.68
radio/tv	2.64

Table 2. Sources of Information Used for Instructional Planning (1=never used; 5=used very often) (N=260).

Respondents also indicated that they use a variety of sources when looking for information to design their lessons, preferring the "berrypicking method" as described by Bates (1989); i.e. consulting several sources, selecting "nuggets" of information from each source as their search strategies, questions, goals, and relevance criteria evolve. Furthermore, although educators describe lesson plans and other instructional resources they find as valuable, they rarely use them "as is," but rather either adapt them to their specific situation, use them as idea generators for their own plans, or use part(s) of them.

There are some interesting differences among groups of subject area educators in their preferred information sources. Looking at the top five ranked sources of information by subject area, journals/newsletters and K-12 textbooks are consistently rated first and/or second most important across subject areas (see Table 3). However, all subjects educators ranked colleagues highest, indicating a higher degree of dependence on other educators for instructional planning information.

Math/Science (n=22)	Language/Arts (n=31)	Social Studies (n=16)
K-12 textbooks (4.14)	Journals/newsletters (3.67)	Journals/Newsletters (4.29)
Workshops (3.64)	K-12 textbooks (3.67)	K-12 textbooks (4.21)
Colleagues (3.55)	Books/magazines (3.67)	Books/magazines (4.14)
Journals/magazines (3.45)	Colleagues (3.47)	Internet sites (3.77)
Books/magazines (3.41)	Internet sites (3.43)	Colleagues (3.50)
Information/Tech. (n=74)	All Subjects (n=72)	Multiple Subjects (n=34)
Journals/magazines (3.93)	Colleagues (3.93)	K-12 textbooks (3.97)
Electronic databases (3.92)	K-12 textbooks (3.79)	Journals/magazines (3.77)
Internet sites (3.91)	Journals/magazines (3.73)	Books/magazines (3.69)
Books/magazines (3.91)	Workshops (3.65)	Colleagues (3.63)
Workshops (3.85)	Books/magazines (3.62)	Internet sites (3.30)

Table 3. Top Five Rated Preferred Information Sources for Instructional Planning by Subject Area (N=249).

Information/technology educators ranked electronic resources (electronic databases, Internet sites) higher than all other groups, probably because this group is more likely to use electronic resources on a daily basis. Social science educators also ranked print resources (K-12 textbooks, journals & newsletters, other books) higher than all other groups likely due, in part, to the importance of original, print-based historical documents. Internet sites were ranked highly by humanities, social science, information/technology, and multiple subjects educators but not by math/science or all subjects educators. Although librarians as a human resource were ranked below 3.0 overall, they were rated above 3.0 by all subjects educators (3.02) and, as would be expected, by information/technology educators (3.52). Radio/tv was rated lowest overall except by social science educators, possibly due to the usefulness of these media for obtaining current news and historical events.

Two hundred-ten respondents (81%) indicated they have Internet access at home, while 193 (74%) have access at school, surpassing the national average (65%) for having access at home or at school (NCES, 1997). One hundred-fourteen respondents (44%) reported having access both at home and at school. High access rates for respondents in this study are, again, likely attributable to the biased sample (AskERIC users) and the Internet access requirement for participation in this study. Interestingly, 43 (17%) of those who stated they have access the Internet at school indicated they never use the Internet at school.

When asked specifically about their use of the Internet as a resource for instructional planning, most respondents (221; 85%) indicated that they use the Internet often (98; 40%) or sometimes (113; 45%) with only 39 (15%) saying they never use the Internet for designing instruction. A closer look at these data by subject area revealed that social science educators are the most frequent users of the Internet, followed by information/technology educators and math/science educators (see Figure 4).

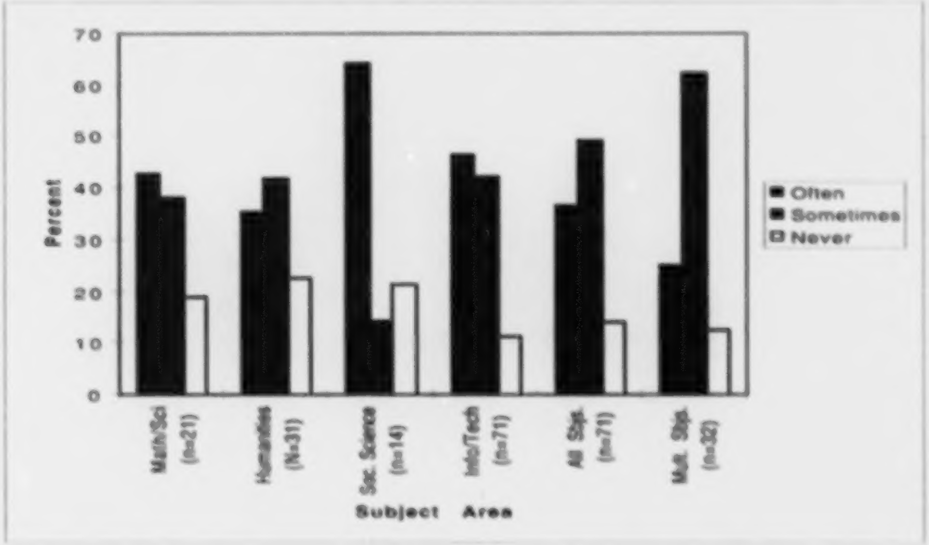

Figure 4. Amount of Internet Use for Instructional Planning by Subject Area (N=240).

(3) When using the Internet for instructional planning, for what types of instructional information do educators search?

Respondents were asked to rate 28 information elements on their importance for lesson planning. These elements included the eight common terms from both content analyses (purpose, grade, subject, topic, materials, grouping, location, and assessment), as well as terms derived from merging similar terms (e.g. instructional style and instructional strategies) and adding one new term(standards) because of the recent development of and emphasis on state and national curriculum standards. Participants were asked to rate each term was rated on a scale of 1=not important to 5= very important. Results show that ten elements were rated 4.0 or higher, including topic, subject, content description, materials (resources necessary for instruction), forms (e.g. handouts, worksheets), grade level(s), purpose (rationale, goals, objectives), outline of lesson, summary and assessment (evaluation of student learning) (see Table 4). Some elements that "add value" to educators' information searches were also rated above 3.0 (e.g. links to state and national standards, comments from colleagues who have used the resource). Of the 28 terms, only author description and publisher were rated below 3.0.

Element	N	Mean	Std Dev
Topic	201	4.39	0.62
Subject	202	4.36	0.71
Content description	198	4.25	0.73
Materials	200	4.24	0.77
Forms	202	4.19	0.81
Grade	203	4.16	0.86
Purpose	202	4.14	0.82
Outline	203	4.06	0.83
Summary	201	4.03	0.82
Assessment	202	4.03	0.88
Materials procedure	199	3.94	0.93
Additional resources	202	3.92	0.82
Prerequisite	199	3.85	0.56
Audience	198	3.78	0.96
Enrichment	201	3.74	0.94
Instructional style	200	3.72	0.9
Time frame	198	3.71	0.93
Scope	197	3.62	1.05
Title	201	3.45	1.07
Standards	201	3.43	1.03
Grouping	198	3.42	1
Comments	202	3.26	1.04
Location	197	3.24	1.07
Date	194	3.19	1.23
Author affiliation	199	3.14	1.12
Copyright	197	3.03	1.19
Author description	198	2.84	1.07
Publisher	198	2.8	1.04

Table 4. Critical Elements of Internet-Based Lesson Plans.

The questionnaire used a critical incident technique, asking respondents to recall a recent experience in which they used the Internet/World Wide Web to find information to use for instructional design purposes. Some examples of the types of experiences described are:

- a middle school teacher wanting to know how to integrate technology into an interdisciplinary language arts/social studies unit on slavery/emancipation for grades 6-8.

- a high school French teacher looking for information on how to create a keypal project.

- a teacher of educable mentally handicapped high school teacher seeking a picture of the human heart "to use with the class as a visual and to assist in the discussion of the human heart."

- a computer teacher looking for computer-based lessons for grades preK-6 on a variety of topics in order to develop an elementary technology curriculum.

- a grade 1-2 teacher looking for "sensory, hands-on activities that included measuring and information on whales" for a science lesson.

- a high school English teacher searching for instructional methods and materials for teaching Shakespeare's Macbeth.

- a science teacher needing information on ways to teach students in grades 3 through 8 how to make holograms.

- an 8th grade civics teacher seeking information about "the positions of candidates on the issues in terms 8th graders could understand."

Participants were asked to specify which Internet resources they found most helpful in their search. Again due to the biased sample, 38 (43%) of total respondents (N=99) cited ERIC or AskERIC. Other specific sites mentioned by more than one respondent were NASA Spacelink; An Aeronautics and Space Resource for Educators (http://spacelink.msfc.nasa.gov/) (7), Texas Education Network(TENET) (http://www,tenet.edu)(4), Carol Hurst's Children's Literature Newsletters (http://www.carolhurst.com/newsletters/newsletters.html) (2), Kathy Schrock's Guide for Educators (http://www.capecod.net/schrockguide/) (2), Children's Literature; A Newsletter for Adults (http:www.parentsplace.com/readroom/ childnew/index.html) (2), and U.S. Department of Agriculture (USDA) (http://www.usda.gov) (2).

(4) How do educators rate their Internet searches in terms of ease, success, and satisfaction with the search process?

A series of subsequent questions asked respondents to rate their recent search in terms of the ease of the search process, the amount of relevant information located, and their satisfaction with the information found. Of those responding (N=204), slightly more participants indicated that their information searches were somewhat easy or very easy (79; 39%) than those who rated them as somewhat difficult or very difficult (62; 30%), while 63 (31%) rated their searches as neither easy nor difficult. (see Figure 5).

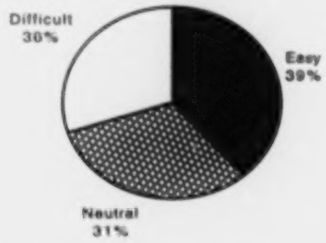

Figure 5. Ease of Internet Search (N=204).

A closer look by subject area found that a majority of math/science (59%) and social science (58%) educators described their searching experiences as easy (see Figure 6). Humanities educators were the only group who rated their searches as difficult more often than neutral or easy.

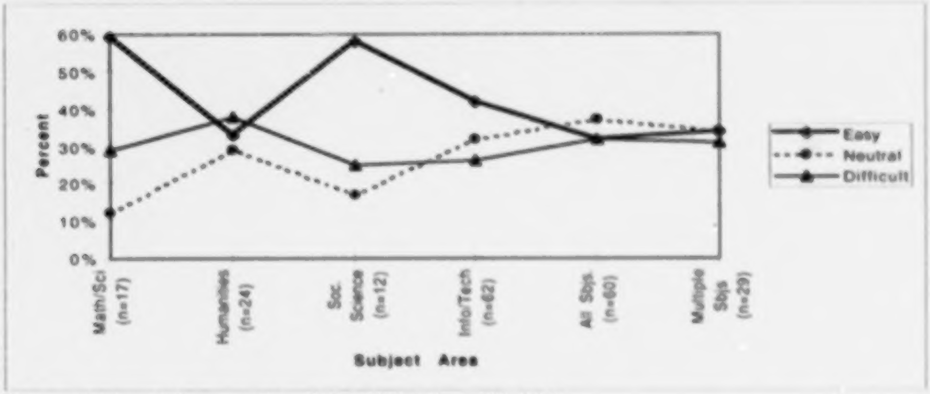

Figure 6. Ease of Internet Search by Subject Area (N=204).

When asked how much relevant information was found, the vast majority (178; 69%) of those responding (N=260) reported finding at least some of the information needed [61(23%) indicated finding most), while only 21 (8%) indicated they found no relevant information (see Figure 7).

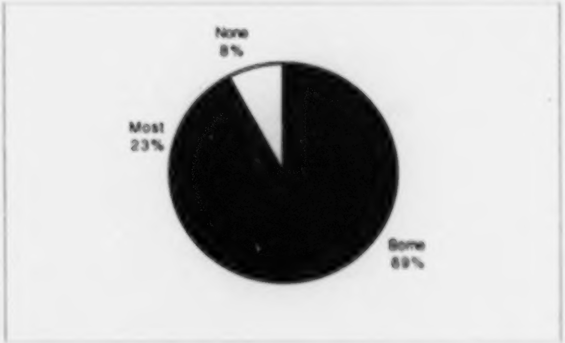

Figure 7. Amount of Relevant Information Found (N=260).

Looking at amount of relevant information retrieved by subject area, social science educators were the most successful with their searches, while all subject educators appear to be least successful (see Figure 8).

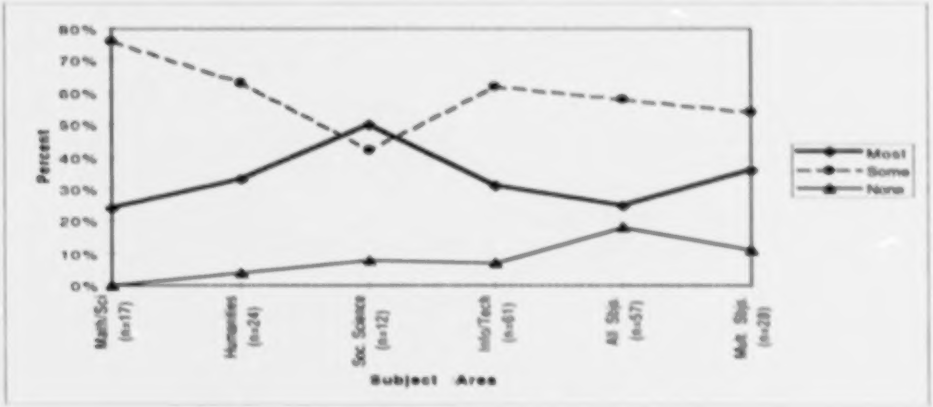

Figure 8. Amount of Relevant Information Found by Subject Area (N=199).

Finally, most respondents (N=203) rated their level of satisfaction as somewhat satisfied (82; 40%) or very satisfied (72; 36%) with search results, while 18 (9%) were somewhat dissatisfied and 8 (4%) were very dissatisfied. Twenty-three participants (11%) indicated a neutral response (neither satisfied nor dissatisfied) (see Figure 9).

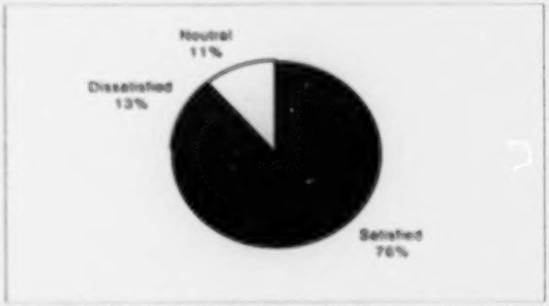

Figure 9. Level of Satisfaction with Internet Search (N=203).

Regardless of ease or search or amount of success, most educators from every content area indicated they were satisfied with their searches (see Figure 10).

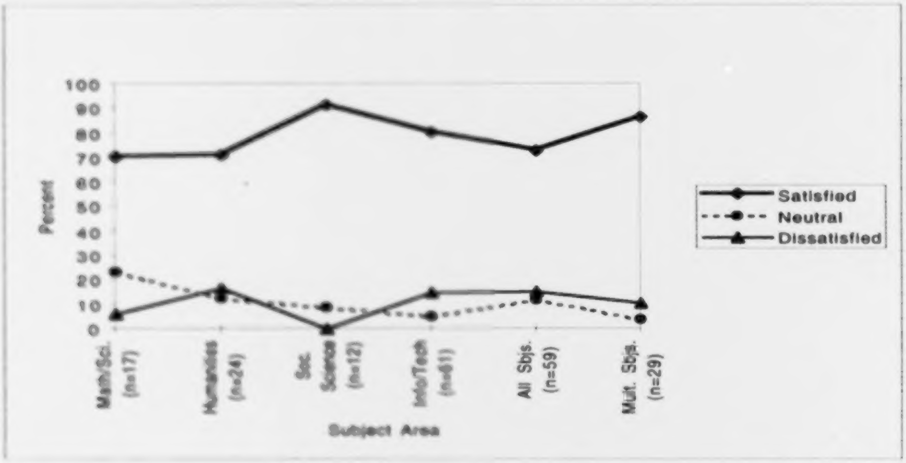

Figure 10. Level of Satisfaction with Internet Search by Subject Area (N=202).

Conclusions

This study used content analyses and an electronic questionnaire to investigate how and why PreK-12 educators use information from the Internet for instructional design purposes. Results indicate that lesson plans are the most sought instructional resource on the Internet. The data also revealed that although most respondents use the Internet for instructional planning, they often consult several resources (print, electronic, human) and use or adapt the information they find to meet their specific instructional needs.

Results of this study have been used to inform the design of the GEM system by identifying the most important instructional elements in educational resources (e.g. topic, grade, forms, assessment), as well as elements that "add value" to their information searches (e.g. standards, comments). These elements have formed the metadata profile that describes all resources included in the GEM system. Future research is planned, including whether certain metadata elements best describe the resources from a particular discipline or domain and whether there are changes in preferred resources (from print to electronic) as GEM provides a more responsive Internet-based environment for meeting the instructional planning needs of educators.

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To be in the world, to be situated at all, is to be in place.
Place is the phenomenal particularization of 'being-in-the-world.'
Edward Casey (1993: xv)

The Importance of Physical Place And Lived Topographies

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Abstract

This paper is motivated by a simple question: when is it important to be physically present in teaching and learning? I will not answer this question directly but rather will articulate a framework for thinking about the role of place in human experience. The motivating question becomes all the more important when one realizes, as does Joshua Meyrowitz in No Sense of Place, that "electronic media destroy the specialness of place" and lead to a loss of sense of place (Meyrowitz, 1985: 125), and when one realizes, as does Michael Heim in Virtual Realism, that most human beings "now dwell in an artificial environment" which is on the verge of becoming virtualized by networked electronic media (Heim, 1998: 153). The original question then becomes: why is physical place even important in our experience? I will try to answer this latter question by reviewing recent work on the concept of place and then presenting Keith Basso's ethnographic work with the Western Apache on their belief that Wisdom Sits in Places (1996). I will end by sketching out further research questions for our field on an "ethnography of lived topographies" in learning places.

Why is Physical Place Important in Our Experience? A Digression

The simplest answer can be stated as follows: we are all embedded in a physical matrix of human and "more-than-human" beings and our lifeworld is situated in the here and now. Furthermore, this physical matrix plays a pervasive role in the construction of cultural and personal identity, so that the more we become distanced from this physical matrix, the more we become distanced from the grounds of our lifeworld and ultimately from the grounds of our being-in-the-world. We, therefore, have to understand the role that this physical matrix plays in all areas of human endeavor. Since physical place is one fundamental aspect of our immediate physical matrix (our bodies are another), focusing on the role of physical place in our experience would do much to further our understanding. To paraphrase Wendell Berry's famous conclusion: we don't know *who* we are unless we know *where* we are (Stegner, 1992: 199).

I was led to this conclusion by an indirect route. I have critiqued the role of computers in education for many years (Streibel, 1986) and have attempted, along with many others in our field, to reformulate traditional theories of instructional development in constructivist directions (Streibel, 1987, 1993, 1996). This led me to look seriously at Lucy Suchman's theory of situated action where physical place played a central role (Streibel, 1995). Contemporary theories of instructional development, however, had very little to say about the physical place where learning was to take place other than in terms of ergonomic factors (Gustafson & Branch, 1997). This current state of affairs in our field could very well reflect the early theoretical influences of behaviorism, communication theory, and systems theory as Rita Richey has shown (Richey, 1986). More recent developments in cognitive theories and information processing theories refine these trends by focusing on what happens inside the "black box" of the learner but little attention is paid to the physical place of learning as a constitutive component of learning (Reigeluth, 1983). Constructivist theories of instructional development moved "outside of the box" by focusing on the social context of learning and the social construction of meaning (Duffy & Jonassen, 1992). Recent developments in constructivist theories have even focused on the design of whole learning environment (Duffy *et. al.*, 1993) and totally virtual classrooms (Hiltz, 1994). However, the physical setting of learning is still not integrated into an ecology of learning except in its ergonomic potential. Speaking of education in general, David Orr, in *Ecological Literacy*, says that:

> other than as a collection of buildings where learning is supposed to take place, place has no particular standing in contemporary education (Orr, 1992: 126).

The same can be said for distance education where "anytime, anyplace" in "virtual classrooms" is promised (Evans & Nations 1989; Keegan, 1996). Perhaps some very deep theoretical assumptions are still very much in force even though specific theories of instructional development have progressed very much. Perhaps the time has come to revisit some of these very deep assumptions. I contend that the concept of place is one of these deep theoretical assumptions that needs to be revisited in order to further our understanding.

Why is Physical Place Important? Some Background

Let me situate my initial answer with some background. A number of scholars such as Edward Casey are calling for a "renewed understanding of the place-world" as a matter of global survival (Casey, 1993). David Orr, in *Ecological Literacy*, claims that:

> education relevant to the transition to a sustainable society, demands first, *an uncompromising commitment to life and its preservation* (Orr, 1992: 133).

Furthermore, real learning "foster[s] a sense of connectedness, implicatedness, and ecological citizenship" and entails a "dialogue with a place" (Orr, 1992: 103, 90). Other researchers, such as C. A. Bowers, on the other hand, have shown how our use of technology is ecologically unsustainable because it embodies cultural values that separate us for the world and cast us in the role of controlling and dominating the material world (Bowers, 1988, 1993, 1994). These contemporary cultural values reflect a kind of psychological modernism that is so aptly described by Thomas Moore in his book *Care of the Soul* (1992). Psychological modernism is:

> an uncritical acceptance of the values of the modern world. It includes blind faith in technology, inordinate attachment to material gadgets and conveniences, uncritical acceptance of the march of scientific progress, devotion to electronic media, and a life-style dictated by advertising. This orientation toward life also tends toward a mechanistic and rationalistic understanding of matters of the heart (Moore, 1992: 206).

Moore continues by saying that when "technology becomes the root metaphor .... there sometimes seems to be an inverse relationship between information and wisdom (Moore, 1992: 206-7). Moore's response is to propose a *reconnection with the physical particularities of person and place* as a way to learn about "fate, time, nature, morality, and character ... [things that are] important in life" (Moore, 1992: 216).

A simple way to characterize this loss of connection with place engendered by psychological modernism is to compare "digital living," as described by Nicholas Negrponte in *Being Digital* (1995) and William Mitchell in *City of Bits* (1995), with "embodied living," as described by Thomas Moore in *Care of the Soul* (1992) and David Abram in *The Spell of the Sensuous* (1996). The comparison comes down to a difference in priveledging the abstract over the concrete. For example, it comes down to a difference between (Streibel, 1997):

1. abstract representations of place (or explicit knowledge of the world - e.g., virtual places, digital representations, etc.) vs. embodied engagement with specific places (i.e., tacit knowledge of the world).
2. abstract representations of self and other (e.g., data structures, avatars, etc.) vs. embodied lifeworlds of self and other.
3. abstract representations of interactions (e.g., intelligent tutoring systems, automated workflow systems, etc.) vs. physically-embodied cultural lifeworlds.

I have cast these distinctions in *either-or* terms in order to highlight their differences. However, if we are to frame a concept of place that furthers our understanding of *both* the technological *and* the natural realms, then we have to come up with a framework that encompasses both and does justice to both. We have, in other words, to avoid *either-or* thinking and *combine the abstract with the concrete* in our thinking and acting. This means *both* an avoidance on over-reliance on abstractions *and* an avoidance of reifying place. I believe that a relational concept of place will help us in this effort. There are many proposals about how to proceed. I will only sketch out a few such proposals and show what they add to a relational concept of place before proceeding to Basso's work which I believe holds the most promising ideas.

Michael Heim in both his earlier work on *The Metaphysics of Virtual Reality* (1993) and his current work on *Virtual Realism* (1998) argues that technologically-mediated virtual worlds and the natural world (or the primary world, as he calls it) make different demands on our bodies so that we basically have to become competent at operating in two worlds. Hence, we have to learn how to become totally immersed in virtual work (and learning) environments and then develop a whole series of "decompression" rituals such as Tai Chi (Chuan) and Chi Kung in order to "reclaim the integrity of conscious life in a biological body" (Heim, 1998: 172). These biologically-embodied physical rituals, in effect, resituate our consciousness in our body's physical place. Heim's proposals are a step in the right direction by focusing on the role of our physical body in achieving a reconnection with the physical world. However, Heim's proposals still set up physical and virtual place in opposition.

Other authors make more radical proposals. Let me give you one example from Edith Cobb in her work on *The Ecology of Imagination in Childhood* (Cobb, 1977). Although her work predates the widespread use of computers, her work with children is a prime example of reconnecting with the physical world. Cobb recounts the story of a young girl who was extremely disassociated from her body and her world except when she went on summer vacations in Michigan. The young girl wrote in her diary as she was recovering by reliving the memory and imagery of her summer world:

> Big trees, pine trees swishing in the wind. The Mountain, blue and hazy in the distance, grass blowing below the waves on the ocean. Sticky bark, blue jeans, that was Michigan - and tennis, lots of it, every day. Then a cool swim, dive off the dock and the water rushing by, swimming, lying on the raft, picnics on the beach, the Point, singing, and marshmallows, sweet and black (Cobb, 1977: 76).

What you see here, as Cobb concludes, is a young girl whose "body image and world image had conjoined, giving a sense of true identity" (Cobb, 1977, 76). Cobb also concludes that:

> individual health is a successful adaptation to the cosmos as well as to culture and society and that this adaptation is temporal and well as spatial - [a mutual adaptation that can] best [be] described by the word 'ecological' (Cobb, 1977:74-5).

The world of a specific physical place and the imaginative memory of that place formed a *both-and* relation which led to physical and mental well-being. Furthermore, *true identity entailed a particularist conjoining of the physical and social worlds.*

The idea that physical place has an impact on our mental well being is becoming a major focus in Architectural design. Since the 1960's, architects such as Christopher Alexander have begun to show that habitability in specific physical places is part of *a deep "pattern language" of all living beings,* and, therefore, calls for a "timeless way of building" (Alexander, 1977, 1979). A key aspect of this timeless pattern language is a "quality [which] is objective and precise, but [which] cannot be named." However,

> in order to define this quality ... we must begin by understanding that every place is given its character by certain patterns of events which keep on happening there (Alexander, 1979: ix-x).

Patterns of living in a place, rather than a reified quality, become the grounds of objectivity. As to naming, Basso will show how the Western Apache culture succeeded in naming such a quality with place-names.

Architects also began to make the case that architecture is a form of healing because of the way that people were influenced by their physical places. For example, Christopher Day, in *Places of the Soul* (1990), calls for designing physical places with "health-giving intent" because "our environment is part of our biography" (Day, 1990: 23). Day is not arguing that a physical place has a reified "spirit" which somehow magically fosters healing. Rather:

> where the environment can offer interest, activity and intriguing ambiguity, timeless durability and a sense of roots (in place, past and future) in the wider natural world with its renewing rhythms .... it can provide support as the first step to recovery (Day, 1990: 26).

How can we approach virtual environments so that they become part of our biography and history in a health-giving way - especially in light of Bower's and Heim's claim that such environments distance us from our physical bodies and the physical places we inhabit? I am only asking this question rhetorically at this point because I want to develop a framework that can begin to address this question. One thing is clear, however. Any new framework has to begin by "embracing the real" and coming to terms with our relationship to physical places. Chellis Glendinning gives a deep reason why this should be the case. In her book, *My Name Is Chellis and I'm In Recovery from Western Civilization*, she writes that:

> our primal matrix grew from the Earth, is inherently part of the Earth, and is built to thrive in intimacy with the Earth (Glendinning, 1994: 16).

Others echo her concern. Charlene Spretnak, in *The Resurgence of the Real*, argues that:

> a truly *post*modern alternative would counter the modern ideological flight from body, nature, and place (Spretnak, 1997: 223).

Hence, a truly postmodern alternative framework would be an *"ecological postmodernism" that focuses on nature, body, and place.* The rest of this paper focuses primarily on place although the other elements are never far away.

The idea of "embracing the real" is not without its dangers because it could lead us back down a path of opposing the abstract and the concrete in an either-or fashion. Hence, we could claim, as does Bill McKibben in *The Age of Missing Information* (1992), that real information can only flow into us through unmediated experience. (McKibben compared watching 24-hours worth of many TV channels over a several month period with a twenty-four hour period out in the Adirondacks). However, both mediated and unmediated (i.e., technologically-mediated and embodied) experiences are "real" in the sense of becoming part of our personal and social biographies. Focusing on how we perceptually-engage other beings no matter what the manner and how this contributes to our personal and social biographies, therefore, seems a better and more fruitful path to follow. This does not discount the real differences between mediated and embodied experiences but it helps us "move out of the map, [and] into the territory," to use David Abram's felicitous phrase, without jettisoning the map (Abram, 1995: 97).

As to arguing for the primacy of engaging the physical world, Abram, in his book *The Spell of the Sensuous*(1996), uses Merleau Ponty's notion of "perceptual reciprocity" to claim that *both* our physical bodies *and* the physical world are always required for meaning.

> The world and I reciprocate each other, [he claims, such that] our spontaneous experience of the world [is] charged with subjective, emotional, and intuitive content [that] remains *the vital ground ... of all our objectivity* (Abram, 1996: 33-34).

This "vital ground ... of all our objectivity" will be a key component of a relational concept of place. Arnold Berleant, *Living in the Landscape*, comes a similar conclusion. "The desire for a congenial integration of body and environment," he writes, "is expressed in a yearning for a sense of place" (Berleant, 1997: 108). (Berleant also says that "continuity [of body and environment] is not always positive" and cites the Pruitt-Igoe Housing Project in St. Louis. 1997:109).

The idea of a "sense of place" in terms of specific local particularities is linked by other authors to ideas of community and the social construction of meaning. Tony Hiss, in *The Experience of Place*, has shown how a sense of place

> allows any of us a direct sense of continuing membership in our communities, and our regions, and the fellowship of all living creatures (Hiss, 1990: xiii).

David Abram expands the notion of communities to encompass the"more-than-human-world" of living and non-living beings (such as whole eco-systems). In each of these cases, personal and communal identity is involved in our engagement with the physical world. This conclusion is made explicit by Daniel Kemmis in *Community and the Politics of Place* where he argues that

> public life can only be reclaimed by understanding, and then practicing, its connection to real, identifiable places (Kemmis, 1990: 6).

Kemmis' ultimate claim is that "no real culture can exist in abstraction from place" (Kemmis, 1990: 7). I would only add that *no real culture can exist in abstraction alone.*

Hence, we come full circle to the premise of this paper, namely, that a new framework for how we construct meaning has to start with our experience of physical place. I would now like to turn to Keith Basso's work with one native American nation - the Western Apache. My reason for choosing this line of inquiry is because the Western Apache embody a relational concept of place in their daily practice. This is not to suggest that we become like the Western Apache or that we appropriate their cultural constructions for our own purposes and interests. Rather, there is much we can learn from them. Although, as Berleant says in *Living in the Landscape*,

> the native North American peoples often identified their bodies in a literal sense with the land and with other things, living and non-living, whose home is that land,

they also hold a view that sees

> humans as an interrelated part of the natural world and that world as a congruent whole, all parts of which possess value and deserve respect (Berleant, 1997: 99).

It is this latter commitment which I would like to retain as I develop a relational concept of place and eventually an "ethnography of lived topographies" for our field, to use Basso's term for his methodology (Basso, 1996: 110). Berleant is even more explicit about this commitment and its relevance to a concept of place. *Our identity as beings in a world of living and non-living beings*, he claims, *is "bound up with its physical place of inhabitation"* (Berleant, 1997: 100).

Wisdom Sits in Places: An Example of a Relational Concept of Place

Keith Basso spent fifteen years living and working with the Western Apache in Cibecue, Arizona. Then, after being asked by tribal elders, he mapped out the living presence of physical places in their community. These places were

> places not far away ... places made memorable, and infinitely imaginable, by events that happened long ago when the people's distant ancestors were settling into the country (Basso, 1996: 8).

The maps of these places were not drawings with Cartesian coordinates but maps of the eye and the mind. The maps contained *place-names* that were "bold, visual, [and] evocative" and *stories* of memorable events in those places that contained lessons for right action. Although place-names were used as "situating devices" in all forms of stories, they were used in *historical tales* as "instrument[s] of survival" (Basso, 1996: 131). An example of a general situating place-name would be "Water Flows Inward Under a Cottonwood Tree." An example of a place-name with an historical tale is "Men Stand Above Here and There." Let me use Basso's own words to describe how the latter place-name was used in a contemporary situation:

> In early June 1977, a seventeen-year-old Apache woman attended a girl's puberty ceremonial at Cibecue with her hair rolled up in a set of pink plastic curlers. She had returned home two days before from a boarding school in Utah where this sort of ornamentation was considered fashionable by her peers. Something so mundane would have gone unnoticed by others were it not for the fact that Western Apache women of all ages are expected to appear at puberty ceremonials with their hair worn loose. This is one of several ways that women have of showing respect for the ceremonial and also, by implication, for the people who have staged it. The practice of presenting oneself with free-flowing hair is also understood to contribute to the ceremonial's effectiveness, for Apaches hold that the ritual's most basic objectives, which are to invest the pubescent girl with qualities necessary for life as an adult, cannot be achieved unless standard forms of respect are faithfully observed. On this occasion at Cibecue, everyone was following custom except the young woman who arrived wearing curlers. She soon became an object of attention and quiet expressions of disapproval, but no one spoke to her about the cylindrical objects in her hair.
>
> Two weeks later, the same young woman made a large stack of tortillas and brought them to the camp of her maternal grandmother, a widow in her mid-sixties who had organized a small party to celebrate the birthday of her eldest grandson. Eighteen people were on hand, myself included, and all of us were treated to hot coffee and a dinner of boiled beef and potatoes. When the meal was over, casual conversation began to flow, and the young woman seated herself on the ground next to her younger sister. And then - quietly, deftly, and quite without warning - her grandmother narrated a version of the historical tale about the forgetful Apache policeman who behaved too much like a whiteman. Shortly after the story was finished, the young woman stood up, turned away wordlessly, and walked off in the direction of her home. Uncertain of what had happened, I asked her grandmother why she had departed. Has the young woman suddenly become ill? "No," her grandmother replied. "I shot her with an arrow."
>
> Approximately two years after this incident occurred, I found myself in the company of the young woman with the taste for distinctive hairstyles. She had purchased a large carton of groceries at the trading post at Cibecue, and when I offered to drive her home with them she accepted. I inquired on the way if she remembered the time that her grandmother had told us the story about the forgetful policeman. She said she did and then went on, speaking in English, to describe her reactions to it. "I think maybe my grandmother was getting after me, but then I think maybe not, maybe she's working on somebody else. Then I think back on that dance and I know it's me for sure. I sure don't like how she's talking about me, so I quit looking like that. I threw those curlers away." In order to reach the young woman's camp, we had to pass

> within a few hundred yards of Men Stand Above Here and There, the place where the man had lived who was arrested for rustling in the story. I pointed it out to my companion. She said nothing for several moments. Then she smiled and spoke softly in her own language: "I know that place. It stalks me every day (Basso, 1990:56-57).

What we have here are all the elements of place in Western Apache culture:

- place-names (i.e., Men Stand Above Here and There) that tie events in a narrative to physical places.
- stories that are "concerned with disruptive social acts ... [and] a stark reminder that trouble would not have occurred if people had behaved in ways they knew they should" (Basso, 1996: 28).
- place-names that give the listener "pictures to work with" rather than moral injunctions.
- physical places that "stalk" the listener and "proclaim by their presence and their names both the immanence of chaos and the preventive wisdom of moral norms" (Basso, 1996: 28).

All of the elements of place, person, situation, and communal historical story are fused into a semiotic relationship. Furthermore, each element changes as a result of this fusion:

- the specific physical place becomes an individual's personally-storied place. It is henceforth permanently experienced in a different way.
- the specific person becomes more linked with the historical community whether he or she chooses to heed the "wisdom" of the historical story.
- the specific situation becomes a unique instance of an historical story.
- the historical story is both reinforced and enriched for future use by how the specific individual makes it part of their personal biography.

In an ironic (to us) way, this is "history without authorities" that simultaneously honors the "wisdom" of the elders. Physical place plays a crucial role here because it is a relatively stable witness by it presence. However, physical place can only play this role in communal sense-making (and survival) when individuals form an "enduring bond with [these] physical places." Place is not an absolute, external reality but a very real and objective part of everyday experience.

The reason that physical place can play such a central role in everyday experience as well as in personal biography and communal history is because

> the constructions Apaches impose upon their landscape have been fashioned from the same cultural materials as constructions they impose upon themselves as members of society (Basso, 1996: 102).

These "cultural materials" are only dependent on an identification of person and place in a phenomenological sense. Physical places, in effect, are not "brought fully into being" until a biography and history of lived relationships has accrued in that place. In the historical place-name example above, a hundred-year-old story of cultural resistance in a specific place was used in a way that the intended hearer of the story would henceforth take very personally. Only then could the physical place "speak" to the hearer. Only then could the physical place "stalk" the hearer. The emotional and meaningful context of such "speaking" and "stalking" would come from the fusion of hearer, community, and place. As Basso concludes, "selfhood and placehood are completely intertwined" (Basso, 1996: 146).

The use of place-names in Western Apache historical stories entails a "running exchange of depicted pictures." At first sight, this might seem like an act of visual memory - much like Yates described in *The Art of Memory* (1966). However, the Western Apache use of place-names goes much further. Each person in the "exchange of depicted pictures" helps construct a unique interactive communication for the hearer. The hearer, in turn, has to "add on" by first drawing on his or her own memory of specific places and stories and, then, by reflecting on how these places and their stories apply to their own unique situation. The cultural construction of meaning, therefore, plays out in both the community and in each individual. Physical place plays a key role here because it is an enduring place/event which shapes the life of the community as well as the life of the individual. Basso writes that

> if the message is taken to heart by the person at whom the tale is aimed ... a lasting bond will have been created between the individual and the site .... [once this has happened] the features of the physical landscape take over and perpetuate [the bond] (Basso, 1996: 55, 60).

The uniqueness and abidingness of place, in effect, *contributes to the uniqueness and abidingness of personal and communal meaning*.

There is much we can learn from the Western Apache about an enduring sense of place. For the Western Apache, an enduring sense of place comes from "lives spent sensing places" and a slow accrual of "multiple lived relationships that people maintain with places" (Basso, 1996: 144, 106). Basso, therefore, concludes that

> this reciprocal relationship - a relationship in which individuals invest themselves in the landscape while incorporating its meanings into their own fundamental experience - is the ultimate source of the rich sententious potential and functional versatility of Western Apache place-names (Basso, 1996, 102).

If we are going to develop a concept of place, we are also going to have to look at how people live their lives sensing places and how they maintain lived relationships with other people in specific places. We will, in effect, have to follow Basso's lead and undertake an "ethnography of lived topographies" if we are going to make any progress.

An enduring sense of place for the Western Apache also entails a close identification of person, place, and the *moral imagination*. Once this is done, sensing places becomes a common, everyday cultural activity and place-making becomes a "universal genre of experience" and a "universal tool of the human imagination." Basso, therefore, concludes that

> if place-making is a way of constructing the past, a venerable way of *doing* history, it is also a way of constructing social traditions and, in the process, personal and social identities. We *are* in a sense [under such conditions], the place-worlds we imagine (Basso, 1996: 7).

This suggests that an ethnography of lived topographies cannot simply deal with the physical characteristics of places but must also deal with the moral imagination that persons bring to the sensing of those places.

Finally, an enduring sense of place for the Western Apache entails a "complex array of symbolic relationships with their physical surroundings" (Basso, 1996: 66). These symbolic relationships are not lived in terms of abstract generalities, but in terms of "symbolically drawn particulars" (Basso, 1996: 144). This suggests that an ethnography of lived topographies has to combine the symbolic and the concrete.

An Agenda for Further Research About Place: More Questions

The discussion so far has highlighted a general rationale for the importance of physical place in our thinking and elaborated specific characteristics of a concept of place that fit into this larger rationale. Basso's example, on the other hand, has offered some specific ways that physical place plays a role in the daily practice of another culture and what that might suggest for an ethnography of lived topographies. What do all these conclusions suggest for further research in our field? I will pose a number of questions which I believe emerge from the discussion.

The most general rationale for the importance of physical place in our lives has to do with reconnecting to the physical world as a culture in the interests of long-term sustainability. David Orr, in *Ecological Literacy*, makes the case that all professions in the modern world have to reexamine how they are a contributory part of modernism and how they can become a contributory part of "ecological postmodernism." The most general question I have, therefore, is:

1. *how can we reformulate the ideas and practices of our field so that they contribute to the transition to an ecologically-sustainable society?*

   This question might seem so general that it is of little practical value. However, if the key to long-term ecological sustainability is an "uncompromising commitment to life and its preservation" (Orr, 1992: 133) and one way such [illegible] commitment can be pursued is by constantly reconnecting our life-worlds with the physical matrix of our existence no matter what our culture, then we can develop some operational specificity to the general question by focusing on physical place. The question then becomes:

2. *how can we reformulate the ideas and practices of our field so that they contribute to a sense of connectedness with our physical world?*

   I have briefly shown, via Basso's work, how the Western Apache culture has done this. However, how do we reformulate the ideas and practices of our field when our personal and social lives are so mediated by technology that our distance from the physical world may be great? The answer to this latter questions is surprisingly simple: we never left the physical world in the first place, we just theorized about it as if it did not matter. Hence, all we have to do is:

a. theoretically - bring the phenomena of everyday practice back into view, and,
b. methodologically - bring an "ethnography of lived topographies" into our research.

This will then help us document how people actually construct personal and social meanings and then help us investigate how they develop a sense of connectedness with the material world.

For persons such as Heim who begin by investigating the phenomenological experience of virtual reality, their research indicates a bifurcation of the experience of virtual and natural worlds. The question then becomes:

3. *How can we incorporate the experience of physical reality into the very concepts and practices of our field?*

My suggestion is that we incorporate a relational concept of place into our thinking and practice. The Western Apache provide a very comprehensive example of a relational concept of place in practice where an understanding of placehood contributes to an understanding of selfhood and social survival.

At this point, a whole line of inquiry could branch off and investigate how personal and social identities are constructed on the basis of body-experience rather than place-experience. I have not pursued this line of inquiry. Others have, from Edmund Husserl, who based his phenomenology on the experience of the body (Husserl, 1960), to Luce Irigaray, who argued that all spaces are gendered (and contested) because they are ultimately based on the experience of gendered bodies (Irigaray, 1993). However, I want to stay focused on the concept of physical place as a foundational concept because I want to address the notion of connectedness rather than difference. This means dealing with how real people live together in real places with other beings. The question then becomes:

4. *how can an ethonography of lived topographies be woven into the work of our field so that our ideas and practices reflect a connection with the physical world?*

I have deliberately left the issue of "digital living" open (i.e., when only the technologically-mediated representations of a person are physically present). Any concept of physical place that entails an accrual process of living in physical places would have to accommodate the physical as well as the semiotic dimensions of representations. I know this is an odd way of stating the issue because semiotic theories deal more with the semantic content of representations than with the physicality of representations. However, if, as the Western Apache have shown in their culture, physical places are "brought fully into being" through a process of sensing and dwelling in *storied* places, then a question for our field becomes:

5. *What is brought fully into being in our cultural context through a process of sensing and dwelling in physical places with mediated representations of people and places? (i.e., what stories come along with representations?)*

For the time being, however, I only want to focus on the effect that a process of sensing and dwelling in physical places has on our construction of meaning. This line of inquiry, therefore, leads to the question:

6. *What characteristics would a relational concept of place have to have to begin to answer all of the previous questions?*

From the earlier part of this paper, a relational concept of place should bring us into closer relation with the physical world and its patterns of "renewing rhythms." This means that it would have to situate us in the physical realm of inhabitation and in the symbolic realm of our social understandings while simultaneously fostering a connectedness with the larger patterns of the world.

A relational concept of place should also foster a greater understanding of our physical and social placeworld by using terms which apply equally well to person, place, and community. This means using terminology that avoids both reification of abstract concepts and reification of concrete places. Let me give you an example from Basso. Basso shows that the Western Apache sense of place is *not*: (Basso, 1996: 143):

- an instinctual *need* of survival (although it contributes to survival)
- a beneficial *attribute* of healthy personality development (although it may have that effect)
- a *mechanism* of social integration (although it may have this effect)

In my discussion, I have also argued that the Western Apache sense of place is *not:*

- a cognitive *structure* of visual memory.

Each of these terms (i.e., need, attribute, mechanism, and structure) are abstractions which become reified abstractions when used as explanations. This is something that a relational concept of place seeks to avoid. On the other hand, Basso has also shown that specific physical places are not absolute, objective entities which have power independently of cultural context. Hence, in Western Apache culture, specific places only "speak" once a pattern of lived relationships has occurred in that place. This, in effect, avoids a reification of specific places. I will generalize Basso's conclusions by claiming that any relational concept of place should avoid these dual reifications but rather express a particularist integration of the physical and social worlds.

A relational concept of place should also help us articulate an ecology of learning. The word ecology is used rather loosely here but it gains specificity if we follow Cobb and believe that this should entail a conjoining of body and place image. Let me give you some specific research questions that would emerge from such an approach:

a. *what are the semiotic relationships that teachers and learners have with respect to their physical places of teaching and learning and how does this semiotic relationship affect the effectiveness of teaching and learning?*

To get a glimpse of an answer, imagine in your mind, if you will, the best teachers you ever had. Do you remember the place where your interaction with them took place? Did that place play a role in your interaction?

b. *what communal stories about the places of teaching and learning do people bring to bear in the act of teaching and learning and how do these stories shape their subsequent ideas and actions?*
c. *how do individuals situate themselves in these storied teaching and learning places and how do they appropriate these stories into their personal biographies?*
d. *how do individual appropriations of storied teaching and learning places reenter larger communal histories?*
e. *how should we design physical teaching and learning places so that when people engage in virtual teaching and learning at a distance, the fused physical/virtual places still connect them to sustainable patterns in the larger world?*

A relational concept of place also has to lead to an understanding of a sense of place that is both rooted in the real and connected to multiple communities of human and more-than-human beings. One way to achieve this is to take a phenomenological approach and investigate how people are engaged in a "perceptual reciprocity" with places and other beings. A phenomenological approach permits us to see:

a. how a place is given its character by the pattern of lived relationships that transpire there,
b. how a person builds up a biography on the basis of perceptually engaging specific places and people,
1. how a community builds up semiotic relationships with places and other people.

In the case of the Western Apache, Basso used a phenomenological approach to show how their daily discourse/practices fused person, place, and stories into living semiotic relationships. What would a phenomenological approach show us about our daily discourse/practices?

If the ideas presented so far have any merit, then a relational concept of place will have to uncover specific cultural constructions that reflect the biographies and histories of lived relationships. In the case of the Western Apache, their relational concept of place was flexible enough to be tied to:

a. specific, concrete storied places,
b. a specific and concrete historical community,
c. a specific and unique people's moral imagination,
d. their personal and communal identities,
2. their survival as an historical community in a larger material world.

In our case, we would have to develop a relational concept of place where large parts of our discourse/practices entail technological mediation. Virtual reality technologies pose a particularly difficult problem here because they seem to extract abstract patterns from every physical substrate except computational devices. Hence, as Heim has shown, even though computational representations are physically embodied in computers, virtual worlds are controlled by computational abstractions. Once these abstract representations are linked by data gloves, head-mounted displays, and even tactile sensors to our entire body, they have the power to completely disconnect our "perceptual reciprocity" with physical places. The question then becomes:

7. *How can we develop a relational concept of place in light of virtual reality developments?*

Indirectly, Basso again provides an answer. Basso showed how a "dialogue with real places" merged the abstract with the concrete because the biography and history of a person was brought to bear on the sensing of places. This was a fusion of perception and imagination. Likewise, if we attend to the biography and history that a person brings to bear on every new situation, whether real or virtual, and if we attend to what people actually *do* in technologically-mediated situations, then we are likely to avoid developing ideas which split the abstract from the concrete. In education, this approach would point us towards issues of real learning whether we are talking about real or virtual places. "Real learning," writes David Orr in *Ecological Literacy*, "always increases intelligence" (Orr, 1996: xi). Real learning, to paraphrase Christopher Day, offers "a sense of roots ... in the wider natural world with its renewing rhythms" (Day, 1990: 26).

I would like to end here with a tentative answer to my original question: when is it important to be physically present in teaching and learning? Even though I have not addressed this question directly, but rather answered the why question in this paper, my answer is simply: always. We should always be consciously present where we are physically emplaced.

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A Paradigm for Enhancing Course Offerings Using CD-ROM, Interactive Video and E-mail

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Introduction

Competition for and recruitment of students in higher education have spawned the development of distance education programs. Institutions, more than ever, are seeking ways to attract learners into time- and cost-effective programs. Multiple delivery mechanisms have subsequently evolved: interactive television, computer based programs via CD-ROM, laserdisks, floppy disks, Internet and computer based compressed video. Selection of the delivery mechanism is generally the instructor's choice. Interactive television and computer based video generally involve synchronous communications and interactions. Instructional techniques tend to be "live," more formalized and teacher directed.

Other modalities are asynchronous. In asynchronous communications, the instructor and the learners interact, but not necessarily in "real time." The learner subsequently has complete choice with respect to when he or she desires to study. Asynchronous delivery mechanisms may involve CD-ROM, laserdisks, interactive video floppy disks, Internet or other computer based, non-real time technologies.

If instruction can be provided at times that are convenient to students, then larger enrollments may be predicted. However, the immediate inaccessibility of the instructor provided impetus for charges relative to lack of quality, Hollywood hype, lack of control, and mass production of learning.

Purpose

The purpose of this study is to describe the results of a year-long effort to explore asynchronous delivery modalities in a distance education program. The study investigates a paradigm for enhancing interactivity in distance education using CD-ROM, interactive video and e-mail. The purposes of the investigation were to (a) create an asynchronous CD-ROM, interactive video and e-mail based distance learning environment, (b) build into the program multiple interactive prompts (readiness, conditional, non-linear branching, consequential, and reflective) and delivery techniques (interactive video, textual, and graphical), and (c) evaluate both accessibility and program impact upon student learning and attitudes. As the sophistication of distance education technologies develops, program designers will be required to evaluate their products and efforts in ways not unlike how instruction is evaluated in classrooms all over the globe. This work is directed at extending this conversation.

Discussion on Interactivity

This study is a continuation of previous exploration on computer-based interactivity by the authors. A subsequent study examined the effect of interactivity on student achievement and affective perceptions and discovered that when delivery modality was controlled, no differences in pupil achievement or affective perceptions were obtained. This finding was judged "curious" and potentially flawed, however subsequent investigations reinforced the finding. One hypothesis for the findings suggested that not all prompts are equal; some interactive approaches may be more effective than others. This finding eventually led to a paradigm for computer-based interactivity that involved four types of prompts that were defined as follows:

Readiness Prompt – a prompt in which the user simply decides whether or not to continue in the program.

Conditional Prompt – a prompt in which continuation in the program is contingent upon successful completion of previous assignments.

Non-Linear Prompts - a prompt in which the user simply chooses from among multiple alternatives which topic he or she desires to pursue.

Consequential Choice - a prompt for which the selection has consequences (the patient dies, the bow runs out of arrows, etc.)

Reflective - a prompt involving written reflection or thinking about a topic or event.

The expectation of the researchers was that programs involving these prompts would entail different learning and different attitudes on the part of students.

Overview

A combination of computer programs, CD-ROM, videotapes and e-mail served as the delivery mechanism for this graduate level Secondary School Curriculum course. During the only meeting on campus, students were introduced to a new method of instruction at Indiana State University. Logistics and methodology were discussed and students were given a computer program consisting of both the course content and instructional methodology. Briefly, content consisted of reading, responding, and interacting with (1) Goals 2000, (2) textbooks, (3) projects selected from over fifty current trends in the education field, and (4) responding to social behaviorist, experientialist and traditional philosophies viewed via interactive video with "attacks" disseminated to other class members on a distribution list, (5) other course requirements. Fifteen assignments in all were required. Responses were e-mailed to the instructor for evaluation and comments. For one out of twenty-five students not having e-mail, content was submitted via floppy disk. Distribution lists were sent to the class members to react with one another on their various stands on law cases, etc.

Instructor Goals For Participants

1. To enable students to become proficient in curriculum planning, its foundations, types, forces, processes, evaluation, criticism, latest trends, decision making and future direction.

2. To enroll students who would not otherwise partake of course offerings by improving accessibility; e.g., non-traditional students.

3. To apply curriculum content, its design, implementation and evaluation into the student's own teaching-learning situation and to become aware of curricular issues and criticism and be able to formulate a response to them.

4. To provide quality instruction through the latest technologies.

5. To improve cost effectiveness by reaching more students at a lower expenditure.

6. To impact students with the application and direct utilization of computers, networking and e-mail to conduct learning activities.

7. To acquaint students with the role of technology in the curriculum and the integration of media into the teaching-learning process.

8. To allow flexibility of time management by studying at home in student's controlled environment.

9. To enable students to become more responsible as an active participant in curriculum development by becoming knowledgeable of the patterns and processes of effective curricular change.

Delivery Mechanisms

CD-ROM and interactive video provide considerable capability for asynchronous course delivery. This program involved instruction that was also based upon graphic, and textual materials. Learners were asked to receive instruction in the prescribed way and respond via e-mail to other class members and the instructor. CD-ROM was used to take advantage of the power and speed of software independent of Internet; also, it is a medium for which we have property rights and will not be widely distributed.

Results

Of the four projects required as of this date (six weeks into the semester), completions stand as follows for the 25 students enrolled:

Project 1: 1 incomplete - 96% completion rate
Project 2: 0 incomplete - 100% completion rate
Project 3: 4 incomplete - 84% completion rate
Project 4: 5 incomplete - 80% completion rate

A few people have completed projects ahead of the due dates including one person who has only one assignment remaining for completion of the course. He should have all requirements in before the mid-point of the semester.

Analysis of Results and Problems

Due to various computer problems, not all students were online at the beginning of the course. Although they could use the post office to mail their projects to the instructor until they obtained the necessary hardware, some did not take the initiative to do that. Hence a major problem of this type of distribution mechanism is evident in that it requires personal motivation to complete the course. Those who do not have this attitude and desire probably are not life-long learners anyway and would fail in other similar attempts, but for most students in the past two years this has been a very successful venture, for the accolades and phrases have been rewarding for the time and energy put into this type of offering. Of those responding in the past to the course evaluation, the ratings were: A, 64 students; B+, 5 students; B, 5 students. There were no lower grades given to this course, therefore it is deemed a successful venture and will continue to be offered in the future, of course with up-grades to keep the content and methodology current.

The Role of Awareness of Cognitive Style in Hypermedia

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Abstract

The focus of this dissertation was to examine the variables of cognitive style, subject awareness of the instructional implications of cognitive style and matching/mismatching subjects with cognitive style. These variables may be important in the design of instructional environments, such as hypermedia, adapted to accommodate individual differences.

Introduction

Individual differences are becoming a focus of current instructional design and practice. It is unrealistic, however, to expect teachers in all educational settings to alter educational environments in order to meet each student's educational needs such as differences in cognitive style. Some of the responsibility for learning must rest with the learner.

Currently, many students are unaware of how knowledge of their own individual differences, such as field dependence/independence, affect the ways in which they learn (Jones, 1993). The focus of this study is to examine some of the critical variables which may be important in the design of instructional environments adapted to accommodate individual differences.

Matching cognitive style to teaching environments may be important because of the potential to enhance learning. However, at this time, the relationship between matching cognitive styles and learning has not been researched fully and the implications are inconclusive, especially for hypermedia learning environments.

This researcher hypothesized that hypermedia could be designed to capitalize on a student's tendency for field dependence or field independence and also designed to compensate for any learning difficulties field dependent/independent students may encounter due to their tendency. In the past, researchers have concentrated on variables other than those directly related to field dependence/independence which may have confounded their results.

Based on the review of the literature, this researcher believed that one of the main problems with studies that match and mismatch subjects with their own cognitive style was that the variable of awareness of cognitive style had not been taken into consideration. Not including this variable presented some potential problems. For example, the subject may be aware of his or her "style" preference prior to the treatment, especially in the case of learning styles and environmental preferences. As a result, mismatching the subjects to learning styles other than their own could possibly alter learning outcomes. In contrast, the subject may be unaware of his or her "style" preference and the potential importance of this preference prior to the treatment, again altering learning outcomes.

Purpose of the Study

There were several purposes for this study. The first was to determine whether matching or mismatching subjects with their tendency toward field dependence or field independence had any effect on achievement in a hypermedia learning environment. A second purpose, related to the first, was to determine whether matching or mismatching subjects with their tendency toward field dependence or field independence had any effect on satisfaction in a hypermedia learning environment. The third purpose was to examine the role of awareness of field dependence/independence as students learned in a hypermedia environment and the resulting effect on achievement. The fourth was to examine the role of awareness of field dependence/independence as students worked in a hypermedia environment and the effect on satisfaction. The final purpose was to explore possible interactions of the variables: awareness of cognitive style, field dependence/independence, and match/mismatch with cognitive style in a hypermedia environment.

Statement of the Research Questions

The following research questions and hypotheses guided this study.

1. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

2. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

3. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

4. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

5. To what extent does awareness of field dependence/independence affect student achievement in a hypermedia Hypercard lesson?

6. To what extent does awareness of field dependence/independence affect student satisfaction with a hypermedia Hypercard lesson?

7. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence), singly or in combination, affect achievement in learning Hypercard?

8. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence), singly or in combination, affect satisfaction with the Hypercard lesson and the learning experience?

Significance of the Study

Kogan (1971) proposes that, "Witkin's field dependence/independence dimension would appear to be ideally suited for research on the interaction between variables of cognitive style and instructional treatment. Both ends of Witkin's dimension have adaptive properties, though of a distinctly different kind, and it is feasible that educational programs could be devised to profit each of the polar types" (p. 252).

The combination of identifying cognitive style, instructional treatment supported by design features related to the cognitive style characteristics and learner awareness of cognitive style may prove to have significant impact on student achievement on a given task and/or student satisfaction with that task.

This researcher examined variables identified as important for future research in other studies. Specifically: (a) determining whether or not field dependence/independence can, or should, be embedded within a hypermedia environment; (b) discovering what role awareness of cognitive style plays in achievement and satisfaction with a hypermedia learning environment; and (c) defining which interactions between variables hold the most potential for increasing achievement and satisfaction.

Definition of Terms

The following terms with the stated definitions were used extensively throughout this study.

Awareness of Cognitive Style - The degree to which an individual understands the instructional implications of specific cognitive style characteristics.

Field Dependence/Independence - The degree to which an individual's processing of information is effected by the contextual field.

Matching Instructional Environments - Instructional environments designed to match a student's cognitive style--in this case, field dependence/independence.

Mismatching Instructional Environments - Instructional environments designed to be mismatched with a student's cognitive style--in this case, field dependence/independence.

Satisfaction - The degree to which students are satisfied with the learning environment, are comfortable with the learning environment, and perceived that they learned from the experience.

Literature Review

Field Dependence/Independence

This researcher chose to begin with the most comprehensive literature review of field dependence/independence (Witkin et al., 1977) and the Manual for the Embedded Figures Tests (Witkin, Ottman, Raskin, & Karp, 1971) because of their extreme importance in setting both a theoretical and practical foundation. Witkin and colleagues (1977) detailed the research done in the area of field dependence/independence over twenty-five years. Field dependence/independence appears to affect many aspects of daily life including the ability to learn from social environments, types of educational reinforcement needed to enhance learning, amount of structure preferred in an educational environment, cue salience, interactions between teachers and students, and career choices.

However, despite the plethora of research detailed by Witkin and his colleagues (1977), these researchers noted additional areas for further research. Many of the suggestions were in the area of interactions between field dependence/independence and the characteristics of the learning environment. It is unknown whether some of the behaviors exhibited by teachers during research experiments are due to the characteristics of field dependence/independence or whether these behaviors are in fact due to the Hawthorne Effect, an observed change in research participants' behavior based on their awareness of participating in an experiment (Borg, Gall, & Gall, 1996).

Another question raised by Witkin et al. was whether teachers can adapt their teaching techniques to accommodate students with different cognitive styles. Related to this question is, what is the effect for both the teachers and the students if the teacher is sensitized to the inherent differences for field dependent and independent students?

Several pages of the Witkin et al. (1977) article were devoted to the conflicting research in the area of matching/mismatching with cognitive style. The researchers only commitéd to the fact that matching/mismatching with cognitive style was a factor in teacher-student interaction. An unknown variable was whether match/mismatch actually improved learning and, if so, how it improved learning. The researchers also noted that other situational variables (i.e., the study moderator) may have impacted the results on matching/mismatching.

Jonassen and Grabowski (1993) devoted an entire chapter of The Handbook of Individual Differences to the cognitive style of field dependence and field independence (a.k.a. global vs. articulated style). They summarized the research on the implications of the style characteristics as

> Instructional conditions that capitalize on the preferences of the field dependent student and challenge the field independent student include:
>
> 1. providing a synergogic (social) learning environment;
> 2. offering deliberate structural support with salient cues, especially organizational cues such as advanced organizers;
> 3. providing clear, explicit directions and the maximum amount of guidance;
> 4. including orienting strategies before instruction;
> 5. providing extensive feedback (especially informative);
> 6. presenting advance organizers (verbal, oral, or pictorial);
> 7. presenting outlines or graphic organizers of content;
> 8. providing prototypic examples;
> 9. advising learner of instructional support needed (examples, practice items, tools, resources);
> 10. providing graphic, oral or auditory cues;
> 11. embedding questions throughout learning; and
> 12. providing deductive or procedural instructional sequences (p. 97).

Instructional conditions that capitalize on the preferences of the field independent student and challenge the field dependent student include

1. providing an independent learning environment;
2. utilizing inquiry and discovery teaching methods;
3. providing abundant content resources and reference material to sort through;
4. providing independent, contract-based self-instruction;
5. providing minimal guidance and direction;
6. asking the learner to pose questions to be answered;
7. using inductive instructional sequence;
8. creating outlines, pattern notes, concept maps, etc.; and
9. using theoretical elaboration sequences (pp. 97-98).

These characteristics were used as guidelines for the development of the treatment used in this research.

Awareness of Cognitive Style

A thorough review of the literature yielded no empirical evidence of the importance of awareness of cognitive style in the design of instruction. However, several researchers (Jones, 1993; O'Brien, 1989; Perry, 1994; Schmeck, 1988; Turner, 1993) suggested considering the importance of student awareness of their own cognitive style and what it means educationally. To date, it is merely a suggestion of value and has not been studied as a factor in research where any cognitive style, including field dependence/independence was a variable. These suggestions have an overall theme--that awareness of cognitive style may increase the ability to recognize that individual needs are not being met. Consequently, these subjects may want to take a substantial part in their own learning.

Schmeck (1988) stated that "placing limits upon self-knowledge ... may be what places limits upon overall cognitive integration. If this is so, then increasing self-acceptance will permit greater self-awareness and lead ultimately to a cognitive style characterized by greater versatility, flexibility, and adaptation in overall functioning" (pp. 149-150). In a situation where accommodation of cognitive style is not being considered, awareness of individual style could lead to self-adaptation to the environment or to the individual's request that the environment be altered to meet his or her needs. This may be critical in the case of the field dependent subject who needs a more structured environment yet finds himself or herself in a very unstructured learning environment.

Perry (1994) commented that if there was an understanding of cognitive/learning styles, cooperative arrangements could be made between individuals of different styles to possibly compensate for the deficiencies of one style. Perry also suggested that an appreciation for diversity was important in any educational environment. This extends beyond the diversity of race and gender to other ways of thinking and learning. According to Perry, when we allow learners to understand how they learn, there is greater possibility for efficient and effective learning and teaching.

Jones (1993) devoted an entire article to the question, "Cognitive learning styles: Does awareness help?" Jones suggested that cognitive styles had general applicability, lended themselves to cross-application over various subject matters; and had a broad usefulness which extended to other areas outside of education. "Due to the fact that the students learn something about their own mental processes, they may then be able to structure and make sense of otherwise unordered experience and of their intuitive or random use of procedures. This has great value in education, most particularly in self-study or independent learning" (p. 197).

Jones (1993) suggested that once a learner is aware of the characteristics for one type of cognitive style, the learner may be able to adopt learning strategies that will make use of their strengths and compensate for weaknesses. Finally, Jones concluded that it is not enough to make a student aware of these cognitive style characteristics; it is also important to include complementing instructional strategies which take into account these characteristics.

Matching and Mismatching with Cognitive Style

Currently, little is known about the exact relationship between matching or mismatching students with their cognitive style and the cognitive style itself. Witkin et al. (1977) suggested that these questions be answered in future research: (a) whether matching for cognitive style makes for better student learning or is it simply that teachers and students with the same cognitive style like each other better? (b) if matching does make for better student learning, why does this occur? and (c) what other variables enter into the match/mismatch environment that may alter outcomes of such experiments?

Shipman and Shipman (1985) questioned whether researchers currently know enough about the match/mismatch variable to make exact determinations of instructional implications. Since the exact relationship is unknown, it is impossible to know whether either matched or mismatched results occur due to characteristics of cognitive style, interpersonal incompatibilities of students and teachers, inappropriate teaching techniques, or differences in personal interests which may be related to the traits of that cognitive style. Rather, Shipman and Shipman suggested that future researchers should either focus on the effects of the match/mismatch or on how to create environments that are adaptive to the needs of field dependent/independent subjects.

Hypermedia and Cognitive Style

Hypermedia is a computer mediated environment which holds great promise for the accommodation of individual differences. Inherent in its special properties, hypermedia has the ability to be flexible or structured, provide varied feedback, and allow the user to access other resources at the click of a button. Ayersman and Minden (1995) acknowledged that there is little research regarding the relationship between hypermedia, learning, and accommodating individual differences. However, they suggested that hypermedia is the ideal way to accommodate a variety of individual differences, including cognitive style. The researchers stated that while other forms of traditional computer-aided instruction are available, other forms require that the instruction be modified or that the learner adapt to the instruction. Hypermedia, on the other hand, has "the ability to deliver information in contextually meaningful sequences, at a variable pace controlled by the learner, and through multiple sensory modalities" (p. 387). In other words, hypermedia can be developed to accommodate various learner needs.

Little research exists in the combined area of hypermedia, field dependence/ independence and the match/mismatch of cognitive style with instruction. However, two studies, both of which examine matching aspects of instruction which correlate to individual characteristics of cognitive style in computer aided/hypermedia aided instruction, will be discussed.

Weller, Repman, Lan, and Rooze (1995) conducted two studies which investigated: (a) possible mismatches between learners' cognitive styles (field dependence/independence) and the presence of advance organizers and structural organizers in the hypermedia, and (b) possible mismatches between learner's cognitive style (field dependence/field independence), social context of learning, and self-regulation of time during HBI (Hypermedia Based Instruction). Junior high subjects in both experiments used a computer ethics Hypercard stack and answered questions on a posttest. Both studies concluded that field independent learners had higher achievement scores overall but that differences in treatment options (the presence or absence of advanced organizers) impacted achievement for field dependent subjects but not for field independent subjects. "These findings suggest that designers of HBI [Hypermedia Based Instruction] should look for ways to take into account the users' cognitive styles. Perhaps hypermedia software should initially diagnose a user's cognitive style and then provide optional modes of interactivity depending on this learner characteristic" (Weller et al., 1995, p. 463).

A study conducted by Hedberg and McNamara (1985) examined the relationship between type of feedback and cognitive style. The researchers found:

1. Field dependent subjects had longer first response time, higher number of first response errors and higher total errors on the task;
2. Field dependent learners performed better when given feedback containing an explanation of errors and strategies for correcting errors, than when given only an indication than an error had been made;
3. Field dependent students reduced their response time and number of errors when given an explanation of their errors and strategies for solving the problems; and
4. Providing detailed explanations of errors and strategies for problem solving did not improve performance of field independent learners. Field independent learners took less time and made fewer errors when given only an indication that an error had been made ("That's not right...Try again").

Research Design and Methodology

Subjects

Since it was essential that the subjects have no prior knowledge of Hypercard, subjects currently enrolled in undergraduate technology courses were asked to volunteer for the study. Volunteers from ET 301 (Educational Technology Applications) were given extra credit to participate in the study and could choose to participate in lieu of attending class to learn Hypercard. Volunteers from ET 201 (Technology in Education) could choose to waive either an assignment involving questions from the textbook or an assignment involving drawing packages, in addition to receiving extra credit.

Internal Review Board approval was given before conducting this study. Volunteers were required to sign a participant consent form prior to the treatment. After the treatment, if the subjects did not believe that they were successful in learning Hypercard, make-up sessions were offered. However, only one subject inquired about make-up sessions. This subject never followed up with a requested for a specific time.

Instrumentation

Group Embedded Figures Test (GEFT)

In order to determine whether students were field dependent or field independent, subjects were given the Group Embedded Figures Test (GEFT) during regular class time and were assigned a student number based on their social security number. The GEFT is an adaptation of the original Embedded Figures Test (EFT, developed in 1950) which has been used to determine field dependence/independence for large groups of individuals (Witkin, H. A., Ottman, P. K., Raskin, E., & Karp, S. A. (1971). This thirty-two item instrument has a correlation of -.82 for male undergraduates and -.63 for female undergraduates with the EFT (Witkin et al., 1971) . The Spearman-Brown reliability estimate is .82 (Witkin et al., 1971). The researcher hand scored the GEFT using a template provided by the publisher.

The Hypercard Stacks

Two Hypercard stacks were developed by this researcher to teach Hypercard, a requirement of the second undergraduate educational technology course. The stacks were designed to assess the subject's knowledge of Hypercard, and to accommodate the special needs of field independent and field dependent subjects. The stacks were based on the Hypercard portion of the instructional packet already in use with current classes. This portion of the packet has been a part of the undergraduate educational technology courses since 1995 and has been updated regularly to correct errors and reflect changes in the curriculum and the software.

The hypermedia stacks were developed with careful consideration of the reported research in the area of field dependence/independence while still focused on the learning objectives. The accommodations for field dependence/independence were mostly in the area of instructional support, the structure of the instructional environment and feedback. The instructional environment for field independence had minimal structure--a menu from which subjects could choose to proceed through the stack in any order. Instructional support was also minimal and was provided only when the subjects sought support (e.g., clickable text, scripting help). Also, the field independent stack provided minimal feedback, only telling the student that he or she was incorrect as they proceeded through the learning task.

The field dependent stack was exactly the opposite. The field dependent stack was highly structured; subjects were required to complete the stack in sequential order before they were allowed to go to the next area. Extensive instructional support was provided; for example, definitions were repeated and users were informed of access to both this researcher and computer lab consultants. Feedback was explicit and corrective

Other than these specific accommodations, it is important to emphasize that the instructional content itself was identical for both the field dependent and independent stacks. This ensured that both groups received equal treatments. Also, both groups were allowed to take notes as notetaking was shown to be of benefit to both field dependent and field independent subjects (Frank, 1984). As stated earlier, both stacks were designed to meet the instructional objectives detailed in the instructional packet currently in use in undergraduate educational technology classes.

Before administration, the treatment stacks were evaluated by subject matter experts in three areas: Hypercard, field dependence/independence, and Educational Technology instruction to establish face and content validity. The subject matter experts examined the Hypercard stacks, checked the accuracy of the design both for content and accommodation of field dependence/independence, evaluated the assessment criterion, and recommended revisions on a printed copy of the stacks. Based upon these comments, revisions to the stacks were completed. This process was repeated until the stacks were accurate and complete.

Achievement Rubric

The next part of the treatment involved application of the student knowledge. Subjects were required to complete their own stacks. They had one hour to complete a short stack which included all of the Hypercard elements that they learned about during the treatment. They were allowed to use the notes that they took during the first portion of the treatment; no other support was provided. These stacks were graded for accuracy according to a predetermined grading scale based upon past Hypercard assessment criteria.

Students were assessed on the following criteria: (a) Hypercard stack created; (b) backgrounds included; (c) buttons included; (d) text fields included; (e) graphics included; (f) hyperlinks included; (g) "pop-up" items using the show/hide commands included; and (h) the overall content and instructional value of their stack. These stacks were graded by this researcher based upon preset point values for the stated criteria. Stacks were submitted with research participant number as the only student identification.

Satisfaction Questionnaire

A satisfaction questionnaire was developed for administration at the end of the treatment. Questions were designed to determine if students were satisfied with the learning environment, were comfortable with the learning environment, and to self-assess learning from the experience. For every question, an equal and opposite question was written to ascertain which wording best asked the question to be answered (e. g., "I liked learning Hypercard via computer" vs. "I did not like learning Hypercard via computer"). Two statistical consultants evaluated the questions for face and construct validity. These questions were then pilot tested with a group of approximately sixty subjects and subsequently scored to determine how effective the instrument was at measuring satisfaction. Finally, the completed satisfaction instrument was subjected to a Cronbach's Coefficient Alpha and a factor analysis to establish statistical validity and reliability. Two of the initial twenty-one questions were dropped after the factor analysis revealed that these questions did not load highly on any factor and the Chronbach Alpha procedure revealed that dropping these questions increased the reliability coefficient. The resulting Coefficient Alpha for the satisfaction questionnaire was .89.

Data Collection

Although two hundred eleven subjects originally took the GEFT, there was subject attrition and incomplete data from some participants. Therefore, the following reflects numbers of subjects whose information was used in the data analysis. One hundred seventy-seven subjects were divided into field dependent or field independent groups based on two factors: their GEFT scores and previous research (Thompson & Knox, 1987) which divides subjects based on the GEFT means for men and women. Since previous research (Witkin et al., 1971) indicated there were different means for males and females, collecting this data gave a more exact description of the sample and provided more accurate information for participant assignment to field dependent/independent groups. Ninety-four field independent and eighty-three field dependent subjects were involved in the treatment.

Once the subjects were divided into field dependent/independent groups, these groups were divided in half using a random number generator. Prior to treatment, one half of the field independent subjects (fifty-one) were made aware of their GEFT scores and the instructional implications of being either field dependent or independent. The other half of the field independent subjects (forty-three) had no knowledge of their GEFT scores and did not receive information about the instructional implications until after the treatment. Also, one half of the field dependent subjects (forty-one) were made aware of their GEFT scores and the instructional implications of being either field dependent or independent. The other half of the subjects field dependent subjects (forty-two) had no knowledge of their GEFT scores and also did not receive information about the instructional implications until after the treatment

In addition, one half of the field dependent/aware subjects (nineteen) were placed in a treatment with an instructional environment that was matched with their cognitive style while the other half (twenty-two) were mismatched with their cognitive style. One half of the field dependent/unaware subjects (twenty-two) were placed in a treatment with an instructional environment that was matched with their cognitive style while the other half (twenty) were mismatched with their cognitive style.

All volunteers signed up for a two hour time slot during which they received the treatment. All subjects were given a disk containing the Hypercard treatment specifically designed for that subject's assigned group. The subjects worked on the treatment independently and according to the specific requirements of that treatment. They had one hour to complete the treatment and one hour to complete the assessment. The assessment portion of the treatment consisted of the students developing a Hypercard stack on their own with only the use of notes taken during the treatment. At the conclusion of the treatment, the subjects were given a satisfaction questionnaire to determine their satisfaction with the learning environment, their comfort with the learning environment, and whether they learned from the experience.

Analysis Procedures

Due to the multiplicity of independent variables (field dependence/independence, match/mismatch, awareness/unawareness) and dependent variables (achievement on the Hypercard stack and responses to the satisfaction questionnaire), a 2x2x2 factorial Multivariate Analysis of Variance (MANOVA) was used with the alpha level set at .05.

If a difference had been found in the overall model, individual univariate procedures would have been performed to identify differences in main effects as well as in the interactions between variables for both dependent variables. According to Stevens (1992), using univariate procedures provides the best power providing an alpha level of .05 is used.

Analysis of Research Questions

This section is divided into a discussion of the data collected and the statistical procedures used in the analysis of each of the research questions. The research questions are restated, followed by an explanation of the data, a summary of the analysis and findings and a statement indicating the retention of the null hypotheses. Tables are presented to display the statistical data and levels of significance when appropriate. Since the dependent variables of achievement scores and satisfaction questionnaire scores were positively correlated (r=.5378), a Multivariate Analysis of Variance (MANOVA) was used for the statistical analyses. Achievement was measured using an achievement rubric. The results were obtained by scoring subject's individually created Hypercard stacks. Satisfaction was measured by obtaining a total satisfaction score based upon the answers to the satisfaction questionnaire.

Analysis of the Independent Variables of Matching and Mismatching

RQ$_1$. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

RQ$_2$. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

RQ$_3$. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

RQ$_4$. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

The results were obtained by calculating individual subjects' achievement and satisfaction scores and comparing these results in matched versus mismatched group. Results of the analysis are indicated in Table 1.

Table 1

Results of the Multivariate Analysis of Variance using Wilks' Lambda for the Variables of Matching and Mismatching on Achievement and Satisfaction Scores

Source of Variation	Multivariate F-Ratio	Degrees of Freedom	p
Match/Mismatch(ma/ms)	.0669	2;164	.9354

alpha=.05
significance indicated by *

The resulting MANOVA statistic of .0669 was not found to be significant for the overall model including the dependent variables of achievement and satisfaction. Thus the null hypotheses were retained. For this sample, subjects who were matched with an instructional environment with support for their cognitive style did not score significantly higher on either achievement or satisfaction than those who were mismatched.

Analysis of the Role of Awareness

RQ$_5$. To what extent does awareness of field dependence/independence affect student achievement in a hypermedia Hypercard lesson?

RQ$_6$. To what extent does awareness of field dependence/independence affect student satisfaction with a hypermedia Hypercard lesson?

The results were obtained by calculating individual subjects' achievement and satisfaction scores and comparing these results for aware versus unaware groups. Results of the analysis are indicated in Table 2.

Table 2

Results of the Multivariate Analysis of Variance using Wilks' Lamda for the Variables of Aware and Unaware on Achievement and Satisfaction Scores

Source of Variation	Multivariate F-Ratio	Degrees of Freedom	p
Aware/Unaware(aw/uw)	.0971	2;164	.9075

alpha=.05
significance indicated by *

The resulting MANOVA statistic of .0971 was not found to be significant for the overall model including the dependent variables of achievement and satisfaction. Thus the null hypotheses were retained. For this sample, subjects who were aware of their cognitive style and its instructional implications during the treatment did not score significantly higher on either achievement or satisfaction than those who were unaware.

Analysis of the Interactions

RQ7. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence) singly or in combination affect achievement in learning Hypercard?

RQ8. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence) singly or in combination affect satisfaction with the Hypercard lesson and the learning experience?

The results were obtained by calculating individual subjects' achievement and satisfaction scores and comparing these results in the interactions between field dependent/independent, matched/mismatched, and aware/unaware groups. Results of the analysis are displayed in Table 3.

Table 3
Results of the Multivariate Analysis of Variance using Wilks' Lamda for the Interactions on Achievement and Satisfaction Scores

Source of Variation	Multivariate F-Ratio	Degrees of Freedom	p
FI/FD x AW/UW	.0688	2;164	.9336
FI/FD x MA/MS	.0801	2;164	.9230
AW/UW x MA/MS	.4446	2;164	.6418
FI/FD x AW/UW x MA/MS	.4824	2;164	.6182

alpha=.05
significance indicated by *

The resulting MANOVA statistics were not found to be significant for the overall model including the dependent variables of achievement and satisfaction. Thus, the null hypotheses were retained. For this sample, interaction effects between the independent variables of field dependence/independence, matching/mismatching and aware/unaware were not found to make a significant difference in achievement or satisfaction scores.

Other Data Analyses

Although the statistical procedures defined by the research design and methodology were used, statistical significance for the hypotheses was not obtained. However, it may be important to document other types of descriptive and qualitative data for further research.

Means and Standard Deviations

There are times when using advanced statistical procedures yields little in the explanation of what occured during data collection. Therefore, an examination of means and standard deviations may document the potential for any unsubstantiated group differences. These descriptive statistics are listed in Tables 4 and 5.

Table 4
Means and Standard Deviations for the Dependent Variable of Achievement

	Achievement		
Group	M	SD	n
FD/AW/MA	5.1842	2.1616	19
FD/AW/MS	5.0000	2.3350	22
FD/UW/MA	5.3409	1.9844	22
FD/UW/MS	4.1000	1.8680	20
FI/AW/MA	4.6875	1.9826	24
FI/AW/MS	4.5909	2.7802	22
FI/UW/MA	4.9815	2.1505	27
FI/UW/MS	5.9048	2.3644	21

Table 5
Means and Standard Deviations for the Dependent Variable of Satisfaction

	Satisfaction		
Group	M	SD	n
FD/AW/MA	46.6111	17.3651	19
FD/AW/MS	46.8571	16.9035	22
FD/UW/MA	40.9090	15.3837	22
FD/UW/MS	41.6500	14.4086	20
FI/AW/MA	44.5000	14.6495	24
FI/AW/MS	44.0682	18.1267	22
FI/UW/MA	45.5185	14.0757	27
FI/UW/MS	53.4048	17.2740	21

The overall means in the case of this treatment were low, both for achievement and satisfaction. However, all eight groups had individuals with higher scores, middle range scores, and lower scores. Note that the means and standard deviations are similar for all groups. There may be other variables affecting achievement and satisfaction different from the independent variables analyzed in this study.

Analysis of Qualitative Data

Although the quantitative data indicated non-significant results, the qualitative data obtained via the open-ended question on the satisfaction questionnaire and from post-treatment conversations with subjects yielded important information. A number of field dependent subjects indicated that they believed it was important for them to have extensive instructional support with step-by-step instruction (a few subjects directly quoted the field dependent/independent information given to them during the instruction). Several of the subjects who were mismatched with their instructional environments were very upset by this mismatching and confessed they were confused and frustrated. Those who were aware of the instructional implications of being field dependent questioned why they were not given a treatment with more support and directions. Those who were unaware of their cognitive style blamed themselves for their failure--many stating that were "no good at timed tests" or were "stupid." The most outspoken subjects seemed to be in the field dependent, unaware, mismatched group.

On the other hand, the field independent, aware, mismatched group was also more outspoken than subjects in other groups. The comments for the field independent subjects differed greatly from those of the field dependent subjects. Comments made by this group included such things as "the instruction was too easy--I thought Hypercard would be easy," and "it drove me crazy to go step-by-step like that--I just got through the instruction as soon as possible." These subjects had a tendency to blame external sources for their perceived lack of success. Note taking was commonly cited as a problem for this group. Subsequent review of notes indicated that the subjects actually took little if any notes and did not write down information specifically mentioned as important for their ability to create their own stacks during the second part of the treatment.

There were some other interesting overall trends pertaining to field dependent versus independent subjects regardless of awareness or matching. Many field dependent subjects suggested their perceived failure on the task was due to human-centered difficulties with the treatment. Several suggested that they needed more support from the *instructor*, not the computer. One subject made the statement that it was important to learn via a social learning environment (quoting information given during the treatment); from human beings--not a computer.

Field independent subjects seemed to desire more access to external resources. These subjects seemed to like learning via computer but would have preferred to be able to ask questions of the researcher during the second portion of the treatment. The qualitative information seems to be in agreement with researchers such as Goodenough (1976).

Discussion and Suggestions for Future Research

The results of this study, in conjunction with the results from other studies, do not support conducting additional quantitative research to measure complex, interrelated dependent learner variables. Separating subjects into groups in order to isolate variables did not yield as much useful information as did the free response data collected with the satisfaction questionnaire. Future researchers should concentrate on qualitative methodologies to examine how individuals interact with learning environments. In the next section, suggestions for future research will be discussed.

Qualitative Research

This researcher believes that it is important to conduct qualitative research concerning the ways in which field dependent and field independent individuals interact with learning environments. As previously mentioned, although it was specifically stated in the initial instructions that they would be receiving their results during the treatment, why were the vast majority of subjects who claimed they did not receive their results field independent? Is there something instructors can do to "force" field independent subjects to read important information during independent learning tasks? Did the subjects not listen to the instructor or read the information because they perceived it to be irrelevant to the learning task at hand? These are questions which may be answered by future research.

For field dependent subjects, is it possible for them to learn and to feel comfortable in an independent, computer based learning environment? Many field dependent individuals commented on the satisfaction questionnaire that they would have been more successful had they learned from a "real" person (not a computerized treatment). Although the treatment was structured to include the adaptations for cognitive style during the instructional portion, subjects worked through the Hypercard treatment on an individual computer. There was no group/social interaction.

Future researchers might want to consider designing an environment with extensive resources and observe how field dependent/independent subjects select those resources. Also, they should investigate which resources are important to learners and if resource selection varies by degree of field dependence/independence. However, to be effective computer based instruction (CBI), extensive front-end analysis, formative evaluation, as well as special design considerations are required. This is not always practical for a single individual to attempt in their own classroom. Instead, including resources such as a live instructor, print materials or other media from an outside source, or peer tutors, in addition to the CBI may be a practical and cost effective way of designing learning environments which support both field dependence/independence.

Cognitive Restructuring

Witkin & Goodenough (1981) discuss "cognitive restructuring"-- the ability of some individuals to restructure the field depending upon the task. After this current treatment, several individuals confided in this researcher that they did not believe the information regarding their Group Embedded Figures Test score fit them at all. Upon further examination, many of these individuals had GEFT test scores which placed them along the mean. Thus, these individuals were neither strongly field dependent nor strongly field independent. The individuals were then asked whether or not they believed the information fit them when interacting with any learning environment. The majority of individuals said that in some cases the information reflected the ways in which they usually learned but definitely not all the time. In the future, it might be important to determine to what degree individuals whose GEFT scores fall along the mean are able to change learning strategies and under which conditions they make this change.

Job Related Cognitive Style Information

Although many studies have shown field independent individuals to outperform field dependent individuals regardless of the task (e.g., Bishop-Clark ,1992; Frank, 1984; Jonassen, 1980), there may be other factors which impact performance, especially on the job. Factors such as missed deadlines, absenteeism and the ability to follow directions might have as great an impact on job performance as the overall quality of one's work. This point is mentioned because at one point during the ten days over which the treatment was conducted, field independent subjects were four times as likely not to take the treatment during their originally scheduled times as field dependent subjects (actual numbers: 3 to 12). It might be of interest to future researchers to examine the role of field dependence/independence on overall job performance.

The Perfectionist Factor

Although achievement and satisfaction were shown to be moderately correlated overall, there was a select group of subjects (twenty-eight) for which this was not the case. For these individuals, a fairly high achievement (7.5 or greater) was paired with a very low satisfaction score (50 and below). Upon further examination of the satisfaction questionnaire data about the reasons they did not believe they had satisfactorily completed the task, many of these subjects indicated that they were unable to accomplish some small portion of the overall instructional goal (e.g., "I could not do pop-ups" or "I could not get my quit button to work"). It did not appear to this researcher that there was a pattern to the characteristics of these subjects. It might be important to consider why these individuals were so dissatisfied with a better than average performance.

The Design of Hypermedia

Empirical results indicate that making subjects aware of their cognitive style and matching or mismatching them with instruction embedded with support for cognitive style did not make a difference for this sample. Comments from students may be important in the design of future hypermedia environments. This researcher has the following suggestions related to the use of hypermedia learning environments:

1. Many subjects may need additional support regardless of cognitive style when completing complex tasks.
2. Support does not always correlate with structure. Many field independent subjects did not like the structure of the field dependent treatment. They would have liked to ask questions of the researcher.
3. Providing plenty of resources, according to Jonassen and Grabowski (1993), may be important for field independent subjects. However, it may also be important to provide similar resources for field dependent subjects. For example, including suggestions for instructional paths in a hypermedia environment which can be printed would provide another "resource" for field independent subjects and provide "structure" for field dependent subjects.

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Technology Tools for Restructuring Course Delivery

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Abstract

As the number and complexity of required technology-related competencies grow, basic teacher education media courses need to develop alternatives to instructor-led lecture-based formats in order to maintain essential components of course content while incorporating new content in expanding technologies. Creating technology-mediated instruction that are used as out-of-class assignments is one way to deal with this issue. This paper presents the process of transforming lesson content from lecture-based format to instructional content delivered through the World Wide Web It details the steps taken to make the Web site instructional and interactive rather than merely informational.

Introduction

The dilemma we all face in delivering technology-based courses is how to add new technology information and skills while maintaining essential existing content. Alternative instructional delivery mechanisms must be explored to deal with the dilemma.

The World Wide Web is host to hundreds of thousands of Web sites. Information is accessible day and night, anywhere in the world, on any topic. The Web is also becoming increasingly used for instructional purposes, not just information delivery. The accessibility of information and the ability to create interactive instruction on the Web make it an attractive medium for the delivery of instruction.

Framework

Courses in educational media are often logical places to incorporate new and expanding technology content for undergraduate education majors. At our university, technology components primarily reside in one educational media course. As we have expanded the course content over time beyond planning, creating, evaluating, and using instructional media to include word processing, graphics, multimedia, and the Internet, existing content is continually revised and updated. By critically analyzing course content, components are identified as possible candidates for alternative instructional delivery. In a continuing effort to develop mediated instruction, selected components of the educational media course are targeted for implementation in alternative, computer-mediated formats.

Visual literacy was identified as one course component that might alternatively be taught through a technology-based medium rather than through instructor-led classroom lecture. Since teachers need to be able to understand, interpret, and create visual images for instructional purposes, a basic understanding of visual literacy concepts is crucial not only in planning and developing visual images, but also in evaluating images for instruction. A technology-based instructional package on visual literacy would give students the capability to learn visual literacy concepts as an out-of-class assignment that could then be reinforced through classroom discussion and course assignments, thus freeing up the contact time for other issues.

Defining Visual Literacy Content

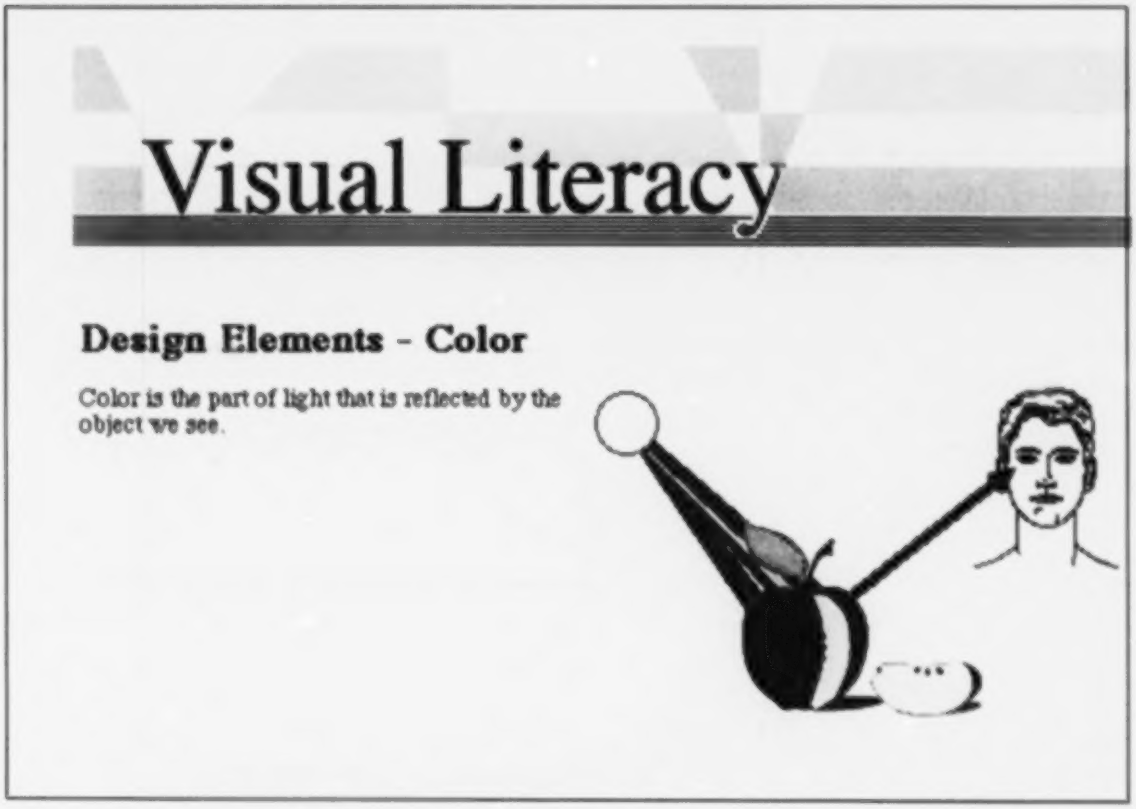
Visual literacy is a required topic in the undergraduate coursework for students preparing for the teaching profession at our university. We are bombarded with visual messages from television, film, books, periodicals, billboards, and computer screens. Painters, sculptors, actors, dancers, and other artists also visually communicate messages to us. Educators need to be able to understand how to communicate visually with their students as well as how to help their students interpret what they see. While entire courses can be devoted to the study of visual literacy, in preservice education the need is to focus on basic principles and key factors rather than the entire scope of the discipline. The content of the lesson in this course includes an introduction to basic visual literacy concepts, visual design elements and principles, factors that impact visual message interpretation, and practical guidelines for producing instructional visual images. This content reflects topics on visual literacy principles from three sources: *Instructional Media and Technologies for Learning* (Heinich, Molenda, Russell, & Smaldino, 1996), *Visual Literacy: A Spectrum of Visual Learning* (Moore & Dwyer, 1994), and *Visual Communicating* (Wileman, 1993).

Design of Computer-mediated Instruction

An instructional design was completed (Kovalik & Shoffner, 1996) to make the transition from an instructor-led lecture-based format to a computer-mediated format. A decision was made to create the instruction in two formats, as a computer-based tutorial and as a World Wide Web site.

After completing the instructional design, storyboards were created for computer-based instruction (CBI) on visual literacy. A subject matter expert and an instructional technology graduate student reviewed the storyboards. Suggestions for changes were discussed with the designer and revisions made where appropriate and necessary. Each CBI screen was designed to contain a minimum amount of text with a related visual image. The images were selected to clarify or illustrate the accompanying text (see Figure 1). All images used in the instruction were either copyright- free clip art or original work of the authors. Obtaining permission to use copyrighted work was too time consuming and potentially too costly. While there are images that would better illustrate a concept, if they were not available copyright-free they were not considered for inclusion in the instruction.

Figure 1. Visual Literacy Website Screen Dealing With the Design Element, Color



Visual Literacy

Design Elements - Color

Color is the part of light that is reflected by the object we see.

Following the design, development, and implementation of the computer-based tutorial, initial formative evaluation was conducted with students in a graduate instructional technology course. Changes were made to correct minor deficiencies, but no major content changes were made. The computer-based tutorial was translated to HTML and uploaded to a Web site. The Web version mirrored the CBI version.

Research Results

The effectiveness of newer interactive technology usage in instruction is open to debate. Moore, Myers, and Burton (1993) state that little actual research regarding the effectiveness of interactive technologies has been conducted and what has been conducted has limited value. Practitioners and researchers call for research that goes beyond traditional comparison studies. Grabowski and Pearson (1988), Slee (1989), Reeves (1986), Kozma (1991), and Moore et al (1993) have made calls for conducting research on the instructional strategies related to the specific attributes of the interactive medium. Hannafin (1992) identified the areas of constructivist models of teaching and acquiring knowledge, hypermedia, and cooperative teaching and learning as innovative instructional strategies that need to be addressed in emerging technology research.

In keeping with these recommendations for examining instructional strategies in technology-mediated instruction, a research study was designed to determine the effects of varying instructional strategies on visual literacy instruction (Shoffner, 1997; Shoffner & Dalton, 1998). The study used a completely crossed 2 (organizational strategy) x 2 (delivery strategy) x 2 (management strategy) factorial design, post-test only control group design. Organizational strategies employed included criterion-referenced, objectivist instruction and problem-based, constructivist instruction. Delivery strategies employed included the local, computer-based instruction and the web-based instruction described above. Two management strategies were used, participation by individuals and cooperative dyads. One hundred thirty-eight undergraduate education students were randomly assigned to treatment groups and a control group and received self-paced instructional treatments. Two weeks after treatment, section instructors collected subject-created instructional media (poster and overhead transparency). At that time, each subject completed a 30-item objective achievement instrument during a regular class session. Subject instructional media products were assessed using a checklist that rated appropriate use of visually literacy concepts. Results from these two measures were combined to produce a measure of achievement. Learners were assessed on performance (achievement), and instructional efficiency (achievement divided by time spent on treatment).

Achievement measures for all treatment groups showed significantly higher levels of achievement when compared to the appended control group. Using multivariate and univariate analyses of variance, data were examined to determine what effect varying instructional strategies had on learning (achievement and instructional efficiency). Results indicated no statistically significant differences between any treatment groups. In particular, results indicated no significant differences in achievement between the computer-based tutorial and the web-based instruction.

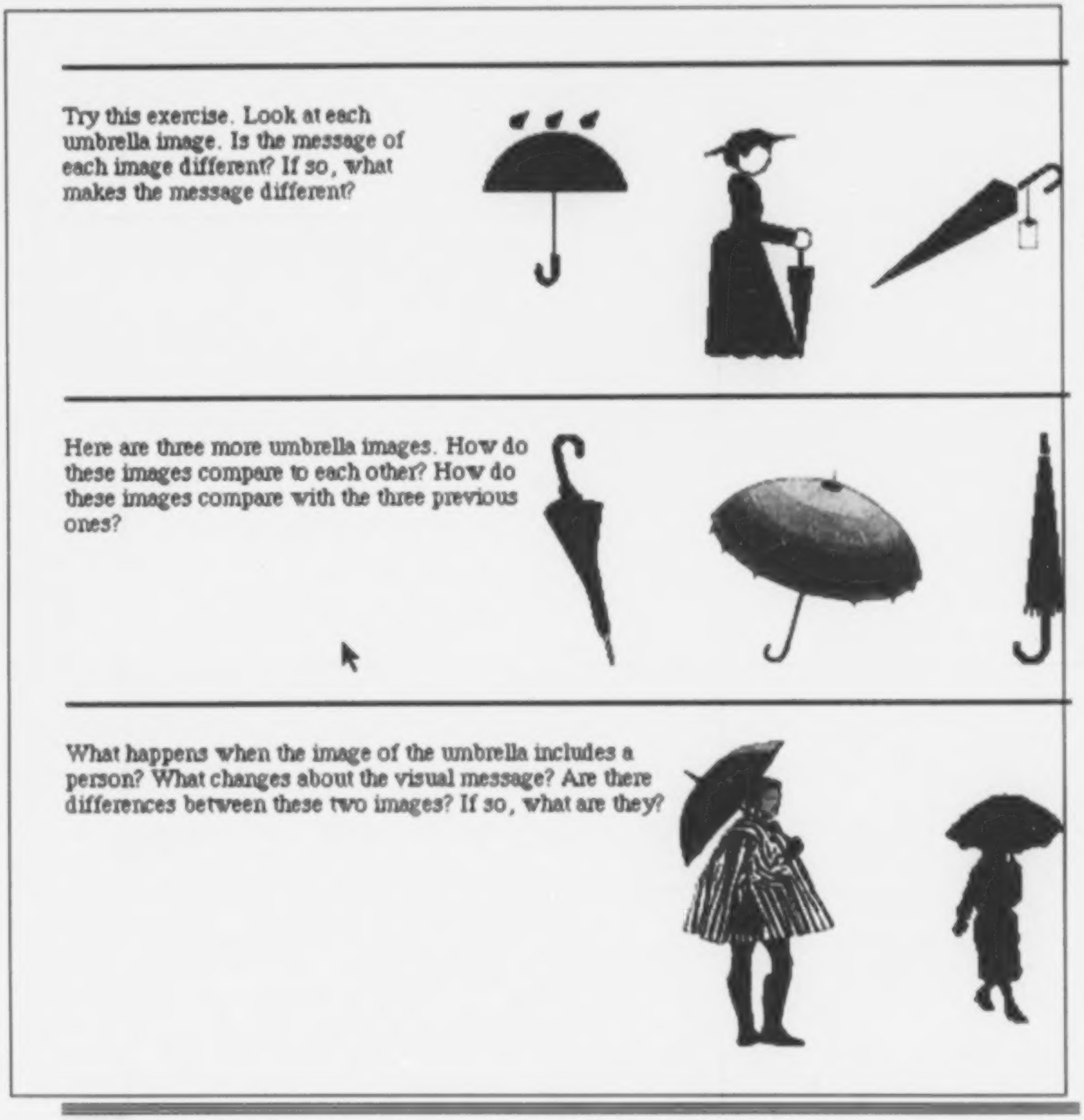
This result was not unanticipated since, in an attempt to control for error, design of the Web versions was highly similar to the respective CBI versions. While initial results indicated that the CBI and web-based instruction were equal in achievement results, we decided to maintain only the Web site. There are several reasons for this decision: (a) Students have consistently commented in course evaluations that the class requires too much time for the credit hours. This perception is largely due to the fact that because of specialized equipment and materials, students must spend much of their out-of-class time in labs to complete assignments and open lab times are not always convenient to student schedules. (b) One of the principles followed in the course is to demonstrate the technology through a variety of instructional delivery methods as well as instructing about media and technology. (c) Some Instructional Technology graduate courses are being redesigned for distributed education. Maintaining this module on the Web makes it accessible to students in these courses as well as the Principles of Educational Media students. (d) Many of the assignments in the courses are dependent on the visual literacy concepts presented on the Web. The information needs to be available on an ongoing basis.

Using web-based instruction allows students to access the site at their convenience, demonstrates an innovative instructional technique, makes it accessible to students in distance learning classes, and makes it available as a reference while completing assignments. The CBI version cannot address all of these issues as easily as the web-based instruction.

Student Feedback

The original Web site provided basic visual literacy information. Even though there are several places in the site where users are queried on the interpretation of visual images (see Figure 2), there is no mechanism to accept user input and provide feedback. Concerned about this lack of interactivity, we continually sought formal and informal evaluative comments and criticism of the site from users. After students completed the Web assignment, they were asked to react to the site in terms of its instructional effectiveness and usability.

Figure 2. Types of Rhetorical Questions Asked in the Original Website



Try this exercise. Look at each umbrella image. Is the message of each image different? If so, what makes the message different?

Here are three more umbrella images. How do these images compare to each other? How do these images compare with the three previous ones?

What happens when the image of the umbrella includes a person? What changes about the visual message? Are there differences between these two images? If so, what are they?

Our results indicate that, overall, users like the Web site. Most feel the site is well organized, self-explanatory, and contains an adequate amount of basic information on visual literacy. A number of users felt they benefited from text/graphic combinations. The ability to see the words and concepts while having the graphic to reinforce the ideas presented was appreciated. User-control was also cited as a positive attribute of the Web site. Students felt that the ability to work at their own pace and the ability to review the information were important to their learning.

The ability to access the tutorial at their convenience and to print the information were also cited as advantages of the web-based instruction. As indicated previously, student complaints about the work involved in the course centered around the need for lab time. The availability of the instruction at any time is an advantage for learners. Students also commented on the change from a classroom lecture-based format to the self-instructional format. When information is presented in lecture format, some students concentrate on writing comprehensive notes rather than on listening to, and trying to understand, content. With the web-based instruction, students can review the information as needed. When students are equipped with content knowledge, class discussion and reinforcement of the content becomes more meaningful. Previously, class time was devoted solely to presentation of visual literacy content. Within that framework, students applied visual literacy concepts to projects with varying success. Since the introduction of the web-based visual literacy site, there has been a dramatic positive increase in the quality of student-created projects. This increase may be partly attributable to classroom discussion, reflection, and critique of visual messages.

Students also provided suggestions for improvement. The majority of suggestions focused on the lack of interactivity. Students indicated they would like to experiment with basic design elements and principles. They also commented that there is a need for interactivity and feedback from the site. The perception was that they could have retained more if it was more interactive.

This emphasis on lack of user interaction from the students and our own recognition that the Web could be more interactive caused us to look for ways to provide interactivity and feedback. Although questions were asked to encourage the student to think about further applications of the information, we had not provided the learner with meaningful ways to test his/her understanding of the concepts or to practice visual literacy skills. Interactive exercises would greatly improve the site. We therefore began to address the identified problems and recommend revisions.

Interactive Instruction

Changes in technology have advanced the potential use of the Web beyond sources of information to interactive instructional mediums. Links to related sites, areas to input data, and ways to send information to and from multiple sites offer one type of interactivity, but there are other possibilities.

Our goal was to modify the visual literacy Web site to make it more instructional and interactive. Instructional strategies designed to improve learning include embedding problem-solving activities, enabling question-and-answer sessions, and adding evaluation measurements. Looking first to interactivity, the original visual literacy Web site included only two interactive functions, pacing and navigation. Our goal was to add the functions of confirmation and inquiry. Additionally, we investigated computer-mediated testing options including single multiple-choice, multiple multiple-choice, single point-and-click, multiple point-and-click, free response, and simulation (Foster and Olsen, 1997).

We first concentrated on ways to add interactivity to the Web site. Several strategies were identified, including providing a realistic problem to be solved using visual literacy concepts, displaying multiple images and asking students to identify relevant visual literacy elements, and providing a visual representation of a concept to be interpreted from multiple cultural perspectives. Options for revision of the visual literacy Web site ranged from a complete reworking of the site, to the addition of a separate path for activities, to making minor modifications, such as adding a multiple choice quiz. Recognizing the strengths of the existing Web site, we decided to build two paths. One path would maintain the current content, the second path would provide the learner with a series of problem-based options. In this way we felt we could best accommodate differing learning styles.

Allowing learners to determine their own learning strategies may be preferable to over-structuring that experience (Kinzie & Berdel, 1990). As noted by Kovalik & Dalton (1997),

> One way learners structure their learning experiences is by exercising control over various lesson attributes including instructional sequence, pacing, and options. Learner control removes the learner from a prescribed, regimented, predetermined lesson sequence and allows freedom of movement in and between lesson components. This freedom often enables the learner to structure the learning experience in a way that may best facilitate fusing new information with preexisting knowledge (p. 162).

Although the Web site allows for movement between lesson components, other learning options were not available. The addition of a path containing relevant exercises provides navigational choice. A learner can elect to traverse the Web site in a linear fashion and then apply knowledge gained by working through the exercises, or, alternatively, a learner can initially try the exercises and refer back to the tutorial to search for answers and gain clarification.

Designing the Instruction

The discussion next focused on designing instruction to meet the needs of our target audience, undergraduate teacher education majors. Of particular concern was the need to provide these learners with the

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ability to evaluate and interpret visuals as well as to create instructionally effective visuals, such as overhead transparencies and classroom handouts. We therefore wanted to incorporate meaningful problems that dealt with both creation and interpretation.

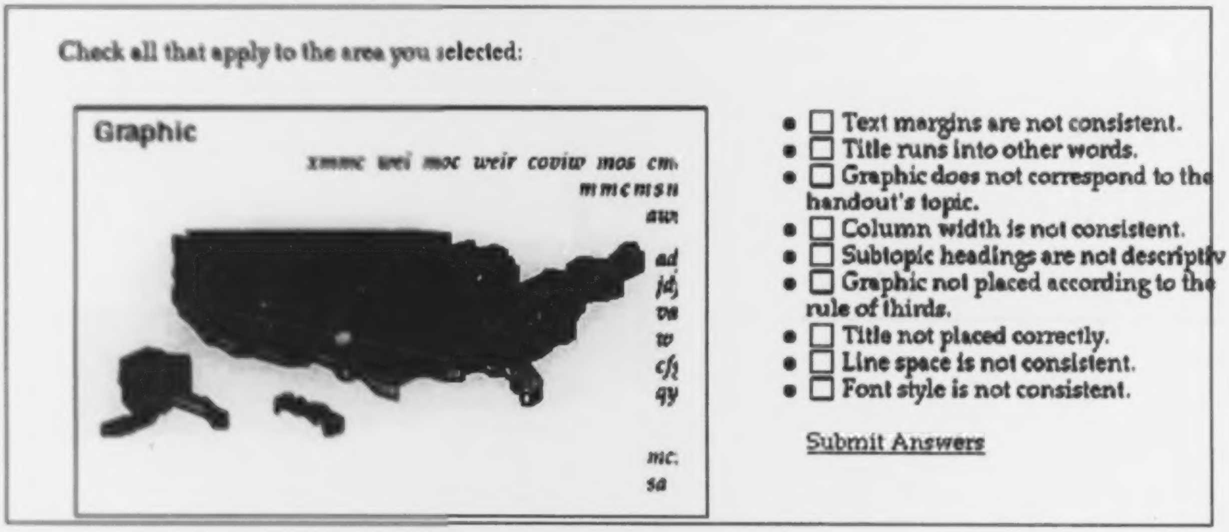
While it would be possible to find instructional activities and images that are already created for this purpose, avoiding copyright complications again became an issue. Also considered was linking to existing visual literacy Web sites for instruction. There are a number of visual literacy sites which could have been used for information but none that we found with instructional activities. We also rejected linking to established sites because of the possible navigation difficulties it would present the learners, the potential wait time for downloading, and the possibility of sites not being available. As Web utilization capabilities change, this issue might be revisited.

The decision was made to develop original activities and possible problem-solving activities were discussed. Guided by a self-paced instructional module (Kovalik, 1995), we brainstormed ideas to identify appropriate activities. Five activities were selected for possible inclusion on the Web site. These activities are: critiquing a handout, identifying design elements and design principles, creating a visual message, selecting appropriate visual messages, and perceptual interpretations of visual messages. Plans are to develop all of these activities; however, only two have been completed to date. Work continues on the remaining exercises which will be added to the site when completed. The two completed activities are described here.

Activity 1 - Critique A Handout Based On Visual Literacy Concepts

This exercise was based on an exercise created by Annette Lamb (1996). Dr. Lamb graciously allowed its inclusion on the Web site. In this activity, the user is presented with the image of a handout that contains errors (see Figure 3). The user is then asked to critique the handout by clicking on a portion of the handout. Each selectable portion of the image may contain multiple visual literacy errors.

Figure 3. Exercise to Critique a Handout

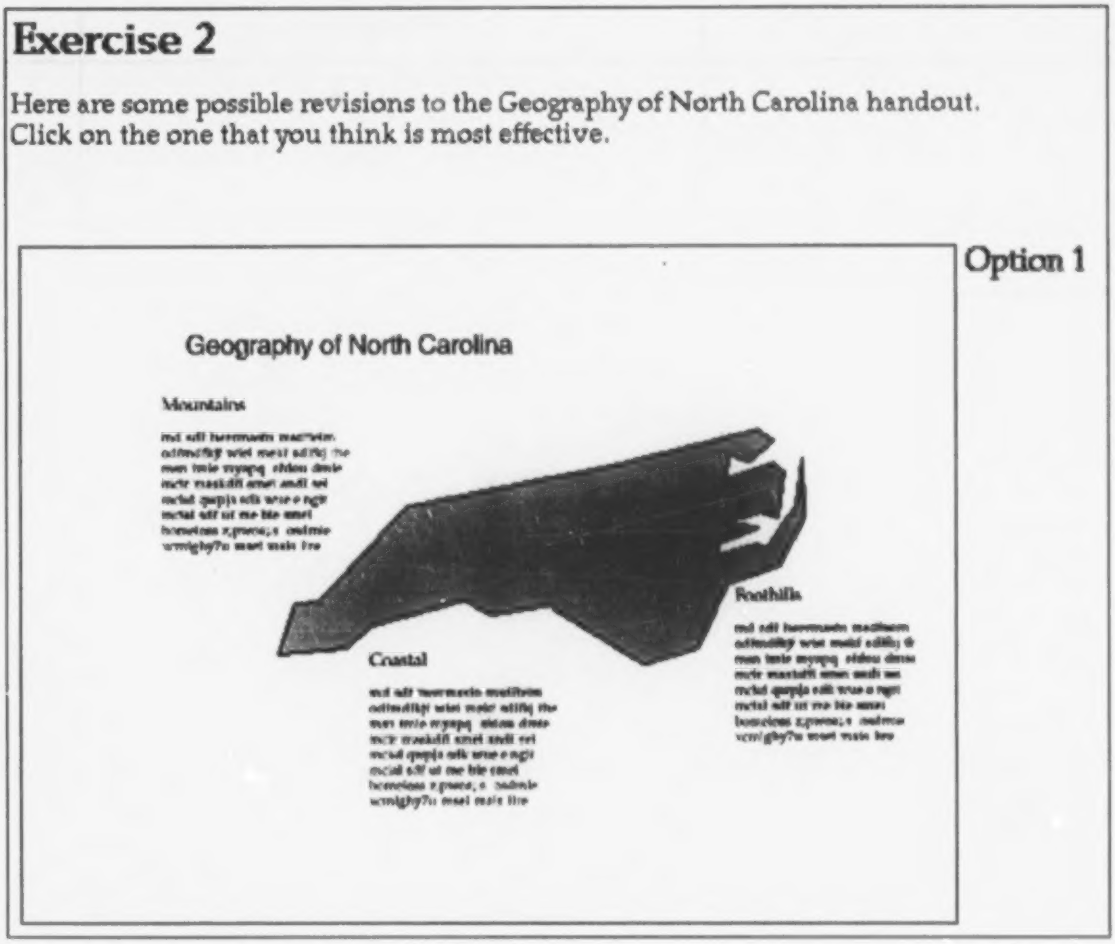


Check all that apply to the area you selected:

- ☐ Text margins are not consistent.
- ☐ Title runs into other words.
- ☐ Graphic does not correspond to th handout's topic.
- ☐ Column width is not consistent.
- ☐ Subtopic headings are not descripti
- ☐ Graphic not placed according to th rule of thirds.
- ☐ Title not placed correctly.
- ☐ Line space is not consistent.
- ☐ Font style is not consistent.

After selecting an area to critique, users see a list of possible errors. The user clicks on all errors that apply to the selection. This approach incorporates a multiple multiple-choice evaluation strategy. This multiple multiple-choice test strategy enables a broader evaluation of learner conceptual understanding since the learner must consider all options as possible correct responses rather than eliminating options until only one "best" answer remains. Feedback is based on choices made by the user. If the user made inaccurate or inappropriate responses, the feedback provides an explanation of why another choice is more appropriate. Users choosing correct responses are congratulated. Following this activity, the user is presented with the option of viewing revised handouts and accompanying explanations of their respective strengths and weaknesses for instructional purposes. (see Figure 4).

Figure 4. Strengths and Weaknesses of the Handout



Exercise 2

Here are some possible revisions to the Geography of North Carolina handout. Click on the one that you think is most effective.

Option 1

Activity 2 - Identify Design Elements And Design Principles

Two graphic images are presented to the user that illustrate a visual literacy concept. The user is asked to indicate which visual literacy concept, element, or principle the image represents. The matching between image and design element/design principle exercise is designed to reflect a single multiple-choice evaluation strategy. For each image, the user is given a selected list of design elements or design principles. The user clicks on the design element or the design principle that the image represents (see Figure 5). Feedback consists of informing the user as to the correctness of his/her response and an explanation of misinterpretations where appropriate.

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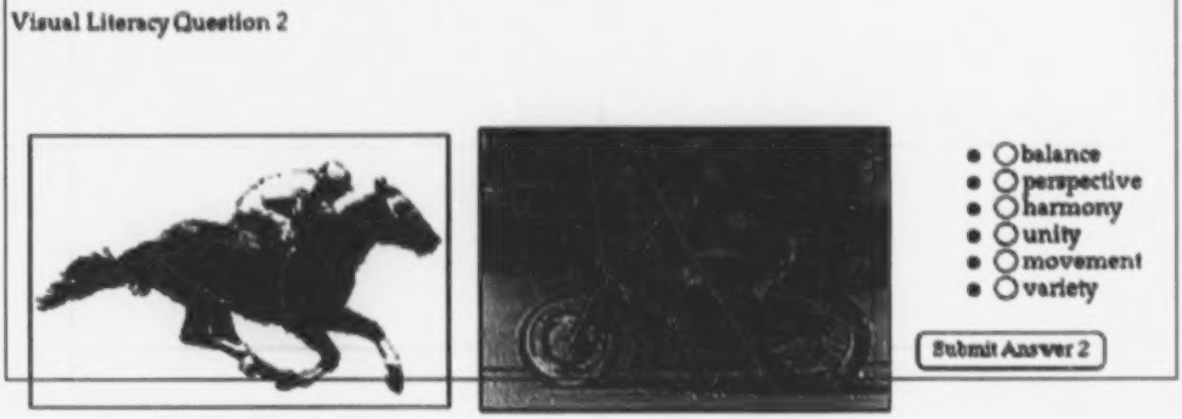
Figure 5. Matching an Image to a Design Principle or a Design Element



Visual Literacy Question 2

The Visual Literacy Instructional Package

We are currently evaluating the effectiveness of the two additions to the site while developing additional ones. We are confident that the proposed changes will improve the instructional effectiveness of the Web site. The use of examples and nonexamples has been an effective instructional strategy in face-to-face classroom instruction. We have seen improvement in student-produced media by employing this technique in the educational media course. In the classroom, examples of student-created posters and overhead transparencies are critiqued. The ensuing classroom discussion provides reinforcement of learned visual literacy concepts. Our goal is to provide similar reinforcement through the interactive exercises on the Web site. While it is important to provide students with a basic conceptual understanding of visual literacy, that is, to provide them with information, it is equally important to provide ways they can practice using this knowledge. It is not enough for preservice teachers to be able to simply recall or recognize correct answers about visual literacy on a criterion-referenced test. In preparing to become teachers, undergraduate education majors must be given the opportunity to actively use and incorporate visual literacy concepts in order to strengthen their visual literacy skills.

Conclusion

Modifying existing preservice teacher education programs to incorporate new content reflecting a growing emphasis on technology requires identification of instructional strategies that allow for maintaining existing course content while adding new content. Technology-mediated instructional delivery is one alternative to classroom contact time. Transforming course content to self-contained, self-paced, computer-mediated formats gives students the opportunity to learn content through out-of-class assignments at their convenience. Using the World Wide Web as the delivery mechanism increases accessibility for students. Instruction on the Web, however, must be more than information. Students need to be given opportunities to practice their knowledge using content in meaningful ways. Additionally, students need feedback related to their progress.

The capability of the Web to provide interactive instruction makes it an effective instructional delivery medium. As we continually update technology courses to address the innovations, the Web will increasingly be used as an effective alternative delivery medium. This paper has presented the transformation of lecture-based course content to computer-mediated instruction on the World Wide Web. We welcome you to visit the visual literacy Web site at http://www.educ.kent.edu/vlo and to share your comments and suggestions with us.

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University Faculty Use of the Internet

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The Internet, one of the most powerful tools ever invented in human history, has changed both the way people communicate with each other, and the way information is accessed. The rich resources on the Internet are beneficial to all educational endeavors, supporting teaching, research and other academic activities. Universities and colleges, where academic dialogue and information resources are essential for professional success, are without a doubt the most likely to reap the benefits of the Internet.

Pioneers on university and college campuses first started experimenting with the Internet in teaching and research, using mainly e-mail, real-time conferences, and most recently, the World Wide Web. These experiments established the value of the Internet as an effective tool in facilitating teaching and research. However, the real impact of the Internet on university campuses will not be effectively realized unless the majority of faculty begin using the network.

Although the benefit of the Internet to education is obvious, research investigating the use of the variety of Internet services by faculty on university campuses is lacking. A careful search of the literature reveals little published research on faculty use of the Internet. The few available studies tended to focus on the use of a particular Internet service, such as e-mail or mailing lists, although the Internet provides many more services. These services include FTP (File Transfer Protocol), Telnet, Gopher and the World Wide Web (WWW). These services can be utilized as valuable educational resources. Consequently, it is essential to investigate how faculty utilize the variety of internet services. Only then, can appropriate strategies be developed to promote the maximum use of the Internet among faculty.

The previous research attempted to provide baseline data about the use of the Internet by academics. However, subjects involved in these studies were either university students or selective network users, and limited Internet services were examined. None of the research dealt with all faculty within a university campus using the broad range of Internet resources,

Schaefermeyer and Sewell (1988) conducted a survey via *BITNET*, the largest academic computer network in the world. Their investigation focused on the use of e-mail by *BITNET* scholars to determine if e-mail was an effective tool for their professional development. The survey found that most professionals used e-mail to communicate with those who shared similar interests at distant locations. Users tended to use e-mail as a tool for research more than teaching. This finding was probably due to the fact that the majority of users did not hold a teaching job. For those that did teach, access to the Internet was limited for their students. They also found that users who responded to their survey were those with quick and easy access to the *BITNET* network. The study identified "speed", "convenience", "time-saving", and "asynchronicity" as the advantages of using e-mail.

Realizing the importance of a computer network for academic development, Grabowski and Pusch (1990) conducted a study on how graduate students at their university used e-mail. Their research generated a profile of likely users in a graduate school and studied factors that promote or hinder e-mail use. Generally speaking, they found that e-mail is used for exchanging information, asking questions, discussing opinions, helping on course assignments, making friends, and alleviating boredom. The study also identified the reasons for using e-mail as : (a) no time/place limits, (b) easy access, (c) knowledge of computers, (d) ease of use, (e) convenience, and (f) try new things (p. 280).

"Mailing lists" is another service provided by the Internet. The "mailing list" concept has been referred to by various names such as listservs, electronic discussion groups, or e-conferences. A mailing list differs from e-mail in that it provides a forum for professionals to broadcast their ideas to a larger audience with similar interests. Judith Weedman's study (1994) investigated how humanities scholars used a mailing list called *Humanist*. Her research confirmed that the list provided humanities scholars with an important vehicle for engaging in exploratory discussions, seeking specific information, posting pre-publication ideas and following new developments in their own and related fields. The study revealed that humanities scholars used the list most for research, followed by professional/technical work, with teaching being the least. Humanities scholars considered the list a useful resource.

The list allowed scholars to reach out to a larger portion of the community of scholars, not previously available andthe majority of them preserved messages posted on the list for a long time.

In another study involving mailing lists, Kovas (1995) confirmed that mailing lists are a valuable internet tool for academics. The study examined the use of mailing lists by professionals in the Library and Information Science field. The survey was sent to 57 library and information science related mailing lists. The findings of the study indicated that mailing lists are an important information source for these professionals, both for personal use and job-related service. They used mailing lists as a source for their own professional and research development, while at the same time using the lists to enhance the quality of library services to patrons. Mailing lists were used as a complement to other information sources such as academic journals, face-to-face conferences, regular mail and phone contacts.

Landis' study (1995) focused on how science educators used a variety of internet resources. The survey was posted to 27 newsgroups and a small group of science educators in secondary schools and colleges responded. The results showed that these science teachers used the internet for activities, which included communicating by e-mail, conducting library searches, downloading information, and participating in newsgroups. Respondents, including the most experienced users, reported difficulties in downloading information from the Internet.

An Australian study (1994) looked at how academics in Australian universities use the Australian Academic and Research Network (AARNet) to support their academic role. Technology directors from thirteen universities were each asked to identify twenty regular users of AARNet in their institutions. A survey was then mailed to these AARNet users. The results showed that e-mail was the service most used (99%) and considered most important (66%), followed by remote login (85%), News (44%), Gopher (15%) and WAIS (6%).

The study provided strong evidence that Australian academics used AARNet "to enhance the efficiency, quality and productivity of their academic work" (p. 29). Australian academics were utilizing AARNet to facilitate scholarly activity in their field; seek and disseminate information, exchange ideas and facilitate professional collaboration. Respondents perceived AARNet beneficial in terms of "increased efficiency; improved access to facilities, data, and collaborators; and an enhanced sense of disciplinary collegiality" (p. 29).

Horney and Henriquez (1993) conducted the first systematic and large scale survey on educators' use of the Internet. The study involved 550 educators, and found that the network is becoming an important component in their teaching and learning activities. However, the survey focused on K-12 educators and did not give any indicator of how university faculty used the Internet.

To date, no research has been found focusing on the university faculty's use of a variety of internet services in the United States. This exploratory study was designed to investigate the use of services available on the Internet by faculty in a public university in the United States; the manner and frequency of faculty use of the internet; their perception of the role of different Internet services in support of teaching and research; and the factors associated with their use of these internet services.

Methodology

The sample population consisted of all the faculty in a public university in the United States during the spring semester, 1996. The total sample population for this study was 180. A questionnaire was developed containing items related to each of the research questions. The questionnaire contained 30 questions with yes/no, multiple choice, and open-ended questions. The questionnaire was distributed at faculty meetings. One hundred and fifty-eight completed questionnaires were collected. The response rate was 88%.

Results

Background information on the faculty included gender, age, their internet experience, and the way they accessed the Internet . Approximately two thirds of the faculty responding to the survey were males (66%). Faculty between the ages of 41-50 comprised the largest age group (45%). Eighty-five percent of the faculty responding to the survey were using the Internet, with their internet experience varying from months to years. E-mail is the service most used by the faculty (96%), followed by the World Wide Web (55%), Gopher (48%), Mailing Lists (29%), and FTP (22%). Approximately half of the faculty had internet access at home (Figure 1 & Figure 2).

Figure 1. Gender, Age and Internet User

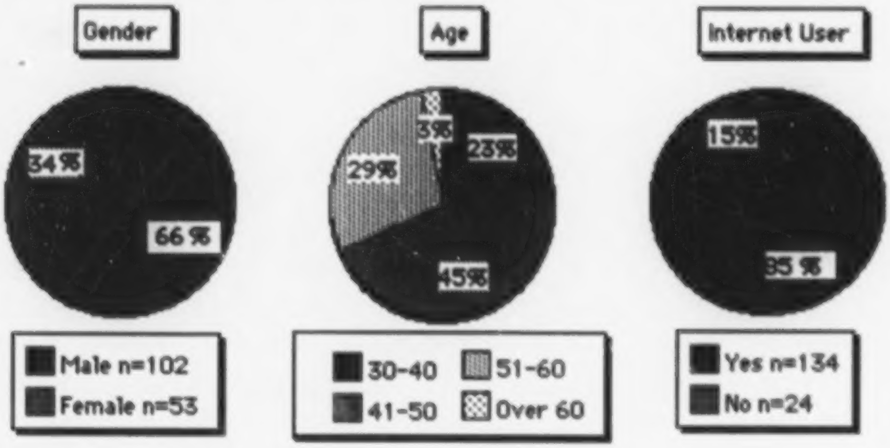
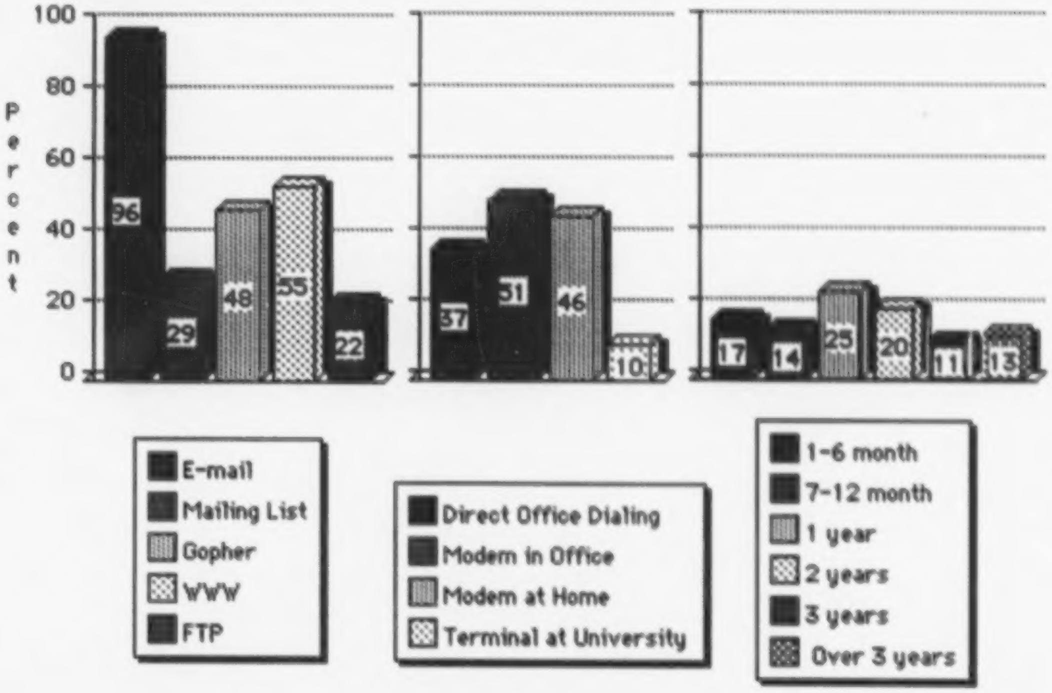


Figure 2. Use of Internet Services, Access and Internet Experience



The time faculty spent using internet services varied considerably (Table 1). Approximately 53% of the faculty spent over three hours per week using e-mail, as opposed to just 25% using mailing lists over 3 hours on a weekly basis. Additionally, 21% used WWW, 11% used Gopher, and only 4% used FTP over 3 hours per week.

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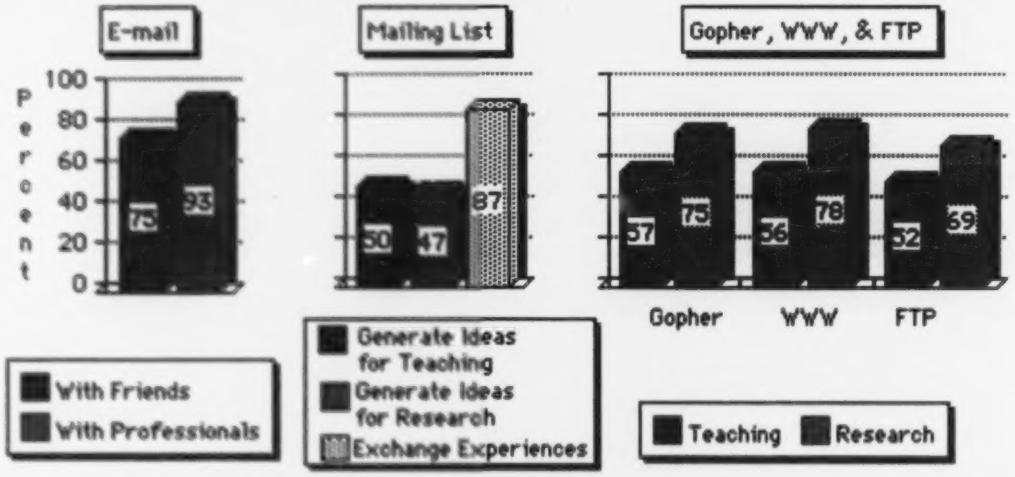
Table 1. Time Spent on the Use of the Internet Services (Hours Per Week)

	1 hour	2 hours	3 hours	4 hours	5 hours and over	n
E-mail	22%	25%	13%	17%	23%	128
Mailing List	39%	36%	0%	6%	19%	31
WWW	53%	26%	7%	5%	9%	62
Gopher	72%	17%	4%	2%	5%	53
FTP	91%	5%	4%	0%	0%	23

The reasons faculty use the variety of internet services are presented in Figure 4. The major reasons given for using e-mail were to communicate with professionals (93%) and friends (75%). Mailing lists were used to exchange experiences with other professionals (87%), generate ideas for teaching (50%) and research (47). Faculty used WWW, Gopher and FTP for research to a higher degree than for teaching (78% vs. 56%; 75% vs. 57%; 69% vs. 52%).

Figure 3. Reasons for Using Different Internet Services



For those responding to the survey, only three faculty provided reasons for not using e-mail. They all indicated they did not have a need. A majority of the faculty did not use mailing lists. Almost 99% reported they did not know how to access lists appropriate to their field or interest (Table 2). Faculty that did not use the other internet services generally had an interest and need, but lacked the knowledge necessary to use the service.

Table 2. Reasons for the Non-Use of the Different Internet Tools

	Lack of Knowledge	Lack of Access	Lack of Need	Lack of Interests	n
E-mail	67%	33%	100%	67%	3
Mailing List	38%	99%	10%	7%	94
Gopher	57%	13%	6%	7%	40
WWW	62%	27%	5%	2%	37
FTP	57%	10%	8%	5%	59

When surveyed about their perception of the importance of internet tools to support teaching and research, the percentages considering internet tools as important or very important were 78% for e-mail, 63% for mailing lists, 69% for Gopher, 74% for the World Wide Web, and 60% for FTP (Table 3).

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Table 3. Perception of importance on the Internet Tools in Teaching and Research

	Not important	Somewhat Important	Important	Very Important	n
E-mail	5%	17%	25%	53%	139
Mailing List	10%	27%	30%	33%	90
Gopher	7%	24%	38%	31%	95
WWW	6%	20%	35%	39%	105
FTP	13%	27%	32%	28%	68

There was no difference in the use of e-mail between the male and female faculty, although there was a slightly higher percentage of female faculty who used mailing lists than did male faculty. More male faculty used Gopher, WWW and FTP than female faculty. However, due to the imbalance of numbers between male (66%)and female (34%), a conclusion cannot be made.

Only four faculty members in the over 60 age group responded to the survey. Faculty in the 31-40 age group were the most active in using a variety of the internet tools. There was a higher percentage of use of each internet service in this age group than there was in other age groups. Again, due to the imbalance of numbers in age groups, the relationship between age and use of internet services can not be determined.

Table 4. Effect of Gender and Age on the Use of the Internet Tools

	E-Mail	Mail List	Gopher	WWW	FTP	n
Gender						
Male	98%	28%	53%	60%	26%	88
Female	98%	32%	38%	46%	14%	51
Age						
30-40	100%	47%	50%	59%	31%	32
41-50	99%	24%	44%	52%	16%	68
51-60	94%	29%	47%	56%	21%	34
Over 60	100%	0%	75%	75%	25%	4

Faculty's perception of the role of a internet service in support of teaching and research was associated with the use of a particular service. There was a higher percentage of use of an internet service among those who considered it important or very important in support of teaching and research than there was among those who thought otherwise (Table 5). Time spent on the internet was related to the use of internet services. The longer the user was exposed to the Internet, the more likely the user tended to utilize the variety of Internet services (Table 6).

Table 5. Effect of Faculty's Perception on the Use of the Internet Tools

	Not Important	Somewhat Important	Important	Very Important	n
E-mail	80%	95%	100%	99%	129
Mailing List	0%	32%	46%	60%	82
Gopher	17%	61%	72%	79%	84
WWW	40%	61%	67%	80%	96
FTP	0%	54%	37%	63%	60

Table 6. Effect of Faculty's Internet Experience on the Use of the Internet Tools

	1-6 Month	7-12 Month	1 Year	2 Years	3 Years	Over 3 Years	n
E-mail	96%	95%	100%	100%	100%	100%	140
Mailing List	18%	5%	31%	30%	41%	61%	140
WWW	18%	50%	50%	56%	47%	61%	140
Gopher	18%	55%	58%	63%	59%	72%	140
FTP	0%	0%	19%	41%	18%	56%	140

Discussion

This study shows that a majority of the faculty at the surveyed university were exposed to internet use. Eighty-five percent of the faculty used at least one of the internet services. Faculty were aware of the role of the Internet in their professional development. They used the internet in support of teaching and research, although some of the internet resources were utilized in a limited way.

E-mail is still one of the most popular services among the faculty even though other internet services, such as the World Wide Web, are gaining popularity in recent years. The popularity of e-mail is probably due to e-mail's role in allowing quick and direct personal communication. Faculty judged e-mail an exciting and convenient tool to keep them connected with professionals world wide. They reported a variety of academic activities via e-mail. Since other internet services are still new to most faculty, this might be another reason for high e-mail use. Faculty need time to learn the technology.

Faculty use of mailing lists was low (29%). Mailing lists provide an important forum for professionals to exchange ideas, information and experiences. They also allow for frequent dialogues and heated debates among professionals, contributing greatly to teaching and research. Faculty who participated in mailing lists were highly positive about their experiences. These faculty reported using mailing lists to keep current on issues of concern and maintain contact with professionals having the same interests. One faculty wrote: "When I was preparing for a new course, I found four mailing lists, all of which included a teacher whose students wished to communicate with students from another culture. I benefited. They benefited. We all did what we do better."

The majority of the faculty surveyed had no knowledge about searching for and subscribing to an appropriate mailing list, which can be a formidable task. At times, it can be like seeking a needle in a hay since countless many mailing lists exist in almost all disciplines. When a seemingly appropriate mailing list is found and a user subscribes, he/she might then find that it is not appropriate to his/her needs. Further, the dynamic nature and frequent obsolescence of mailing lists contribute to frustrations encountered with finding appropriate mailing lists.

However, to alleviate some of the frustrations, information about mailing lists is becoming more pervasive. Faculty can use these information to locate an appropriate mailing list, rather than relying on random database search. Some academic journals and magazines now recommend mailing lists to their subscribers. Faculty who find beneficial mailing lists can pass the information to their colleagues. Using mailing lists that are recommended and tried by other professionals saves a great amount of time and anxiety for faculty new to mailing lists. Another source of information about mailing lists can be obtained from professional librarians on university campuses.

For information search and retrieval, the World Wide Web showed the highest rate of use, with Gopher rated the second and FTP the lowest. Compared with Gopher and FTP, the World Wide Web has a better user-interface for information access and retrieval. It has the advantage of allowing users to make links while navigating through information. Users can also see the information before they decide whether they want a copy of it. In recent years, enormous amounts of information is available on the World Wide Web. However, each service has its advantages and disadvantages. Faculty need to be aware of potentials and limitations of each internet service and utilize them to their benefit.

The results of the study indicate that faculty used World Wide Web, Gopher, and FTP more for research than teaching. Moreover, it seems that faculty turned to other resources such as e-mail and mailing lists for exchanging and generating teaching ideas.

Even though the World Wide Web comprised the highest rate of use, only about half of the faculty were using it (55%). Among those who used the World Wide Web, about one fifth spent over three hours per week using the Web. Faculty expressed their frustration in their comments which included, "The World Wide Web is short on information, causing waste of time searching different web sites," "The World Wide Web is complex and time consuming," "Get stuck in the mud during surfing."

Information searching on the World Wide Web is a challenge. The way information is arranged and accessed differs from traditional information resource organization in a library. Faculty need to break their habitual patterns of information seeking behavior and develop new information seeking strategies. At the moment, information searching on the World Wide Web for most people is like combing the beach for treasures. This process of "treasure hunting" is not attractive to faculty since most of the time, they want immediate access to the information they need. If they experience any frustration in accessing and retrieving information, faculty will look to other sources.

Information searching on the World Wide Web is complex since it requires both technical skill and information searching skills. Neither skill alone can complete the task. The types of information available on the World Wide Web might also influence faculty use. One possible solution is cooperation between campus librarians and faculty to develop their information searching skills. Librarians and faculty can work together to locate and disseminate discipline-specific World Wide Web sites.

The results of this study pointed to the need for faculty training in order to promote the maximum use of internet services. This was also indicated in the many comments found in the survey.

Training workshops should be offered in a variety of formats, including hands-on workshops, seminars, and strategy sharing workshops. Workshops should not only focus on the technical aspect of the internet, but on increasing faculty's awareness of available internet resources, the role of the Internet in teaching and learning, strategies of surfing the Internet, and the potential and limitations of each internet service. Workshops should answer questions such as; What is the appropriate tool for a particular networking activity? What are the strategies for information searching and retrieval? How to incorporate the Internet resources into classroom activities? How to utilize resources such as on-line help and Internet reference books?

Training should be offered on different levels; university, college, and division. Training workshops should provide immediate benefits to faculty and be relevant to their professional development. When faculty can see a clear pay off, they will be motivated to learn to use the Internet.

Training should be done as a team effort. Librarians, experienced internet faculty users, and technical staff should work together to design and offer workshops, utilizing each others' expertise. With their professional skills in seeking and accessing information, librarians can play a key role in training, coupled with the subject expertise of faculty and the "behind the scenes" technical support of the technology staff, training curriculum can be designed to meet the needs of faculty at all levels.

Though faculty training is essential in promoting the use of the Internet, faculty can only gain experience by actually using the Internet. Technical support is crucial to ensure faculty's use of the Internet. Even the most experienced users can encounter difficulties using the Internet. The majority of the faculty reported that their most frustrating experience was having technical problems while using the internet. This included logging on failure, computer crashes, getting cut off in the middle of sessions, and difficulties in downloading and uploading files. Faculty need access to technicians who are available at any time to address their technical problems. As one faculty indicated: "I wish there were more specific individuals on campus who could address technical questions about the Internet."

It is unlikely that universities can hire an adequate number of technicians to provide such a timely service. Usually, available technical staff on campus are busy operating and maintaining the campus network, making it almost impossible to help individual faculty solve his/her technical problems. One solution might be to utilize students as resources. For example, students majoring in the Computer Science could take practicums and be assigned to specific departments or colleges to help faculty members.

Conclusions

This study generated baseline information and provided insights on how faculty use the internet. With the aggressive development of computer technology, the Internet will play an even greater role in academic settings, presenting a great challenge to university faculty. There are many factors that impact faculty use of the internet. It is essential to continue studying how faculty use the Internet and identify the factors associated with internet use so that the benefit of the internet can be fully realized.

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Evaluation of a Graduate Seminar Conducted by Listserv

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Abstract

This study examines the efficacy of a class discussion conducted by listserv which was used instead of classroom meetings for a graduate seminar. Advances in communication have stimulated educators to evaluate new methods of instruction taking advantage of the growing interest in distance learning.

Educators have recognized that the advent of computers and the World Wide Web is profoundly changing the methods used in education (Goodman, 1995; Polyson, Saltzberg, Goodwin-Jones 1996; Boon, 1996). One aspect of this evolving field is the use of listserves for distance learning and specifically its use as a means of distance classroom interaction (Partee, 1996).

The impetus to use e-mail for educational purposes is derived from the many possible advantages it offers. Theoretically, e-mail, in a distance learning environment, should allow a means for interaction among diverse students and teachers that would otherwise be missed in a classroom situation. Also, by overcoming the problems of distance and time, e-mail may allow students from great distances and other cultures to participate in the class, and consequently to enhance the value of the course for all the participants. Furthermore, e-mail may allow interaction at the convenience of the participants (Partee, 1996). Another advantage of e-mail is the time it allows the user to construct responses that are well thought out and not time limited as in traditional classroom seminars. With the increasing use of e-mail in education, it is important to make the best use of this modality. Having this objective in mind, the focus of this study was to evaluate the communication that transpired during a graduate seminar conducted by listserv. This study was exploratory in that the goal of the study was "to investigate a little understood phenomena" (Marshall and Rossman, 1995, p. 41) and to identify strengths and weaknesses in order to "generate hypotheses for further research" (Marshall and Rossman, 1995, p.41). It is not a definitive study.

Review of the literature

While there is increasing information about the use of telecommunication in learning and the use of the Internet for communication and discussion groups, there is very little information on the actual use of e-mail in conducting a class by listserv. One study completed at Queens University in Belfast compared computer-supported seminars with face-to-face seminars (Newman, Johnson, & Webb, 1996). They found that critical thinking was deeper in computer conferences. The evidence of critical thinking was demonstrated by the cognitive reasoning skills. The Belfast study group developed a set of paired opposites, one an indicator of surface processing and one of in-depth processing. "For example, making judgments without offering justification, versus setting out the advantages and disadvantages of a situation or solution." (Newman, 1996, p.66). They also found that the students in the computer conferences brought in more outside relevant material and were better at linking together ideas and solutions. On the other hand, the face-to-face seminar students came up with new ideas more often. The e-mail students seem to have a more serious style and produced a higher ratio of important statements.

Another paper described the results of a conference for teachers in which interactive e-mail discussions were conducted over a period of 2 months prior to a 3 day seminar and for 1 month afterwards (Rud, 1995). The participants felt that the use of computer communication allowed them to explore their own practice as a teacher more by fostering awareness of wider issues in information technology. It also brought to attention multiple avenues for effectiveness in teaching many kinds of students. Furthermore, it allowed them to share ideas with others who lived at a distance from them.

A study of communication patterns among undergraduate student groups using e-mail was done at the University of Minnesota by Miller (1994). The study was of exploratory nature, but it did demonstrate the ability to manage micro-level communication dynamics in the transcripts. Another report on the use of a listserv in a communication course at a liberal art college concluded that e-mail afforded a valuable additional channel of communication between instructor and students (Bruning, 1995). A report on the use of a listserv for a graduate elementary education course concluded that the listserv enhanced both the graduate and teaching experience of the teachers while providing an alternative communication option (McGinnis, 1995).

A study by Ross (1995), provided four recommendations for using a listserv.

1. Technical factors must be addressed to insure easy confident communication.
2. Novice users need skill development with the technology. This skill can be a prerequisite for the class or training in e-mail becomes part of the course content.
3. Arrangements for setting up students' accounts should be made in advance.
4. Students should be informed early on about the expectations of their participation on the listserv.

Because of the growing use of e-mail communication it is important for educators to learn how best to use this new method of instruction. It is necessary for teachers to learn from the experience of those already using this method so that they may better formulate their own teaching program.

Research Questions

The purpose of this study was to examine what kind of communication transpired during a graduate seminar in which the discussion was conducted by listserv. Two questions were of primary interest in this study. First, was this mode of communication successful for the purpose of the course? The purpose of the course was for each student to demonstrate the ability to critically analyze and synthesize theoretical and conceptual works from the field of instructional design and technology. To answer this question, these questions were asked,

9. Was there evidence of critical thinking by the students revealed in the e-mail communications?
10. Did the students correctly understand the previous communications?
11. Were any misunderstandings corrected?
12. Were emotions revealed in the communications?

The second question was how could this mode of communication be improved as a means for replacing or supplementing face-to-face classroom discussion?

Methodology

Participants

Eight students and two faculty members made up the discussion group. Of the students, five were female and three were male. There was one female and one male faculty member. Six students were working on their Doctorate of Education degree, and two students were working on their Master of Science degree. All the students had a concentration in ID&T. Students could use either a free University e-mail account or any e-mail account of their choosing.

Design of the study

This is a retrospective study examining all of the listserv messages that occurred during the seminar. The participants, both students and faculty, were unaware that this study would be conducted. The listserv software automatically archived all e-mail messages for future use. In addition to study of the listserv messages, all the students were asked to complete a questionnaire a the end of the course. The instructors were interviewed concerning their impressions about the use of listserv for the discussion in this class.

The class chosen for this study was a seminar in Instructional Design and Technology: Perspectives Past, Present, Future led by Dr. Gary Morrison and Dr. Deborah Lowther at the University of Memphis. The class met twice face-to-face at the beginning of the semester and once at the end. Other than these three meetings, the class was conducted by listserv. Twenty percent of the student's grade was based on their participation in the class discussion.

This class was chosen for analysis because it was one of the first efforts using listserv as a means of class discussion at the University of Memphis. In many ways this course provided an ideal subject for analysis to answer the questions proposed by the research inquiry. The course had a small number of students, so everyone had ample opportunity to participate in the discussion. The students and instructors were all computer competent. Another advantage in the choice of this course was that the discussion played a significant role in developing the purpose of the course and leant itself well to the use of listserv.

Procedure

A listserv is a mailing list of collections of e-mail messages that pertain to specific topics of interest. The e-mail messages are collected at one site, also called a listserv, and mass e-mailed to those who subscribe to the particular list (Settles, 1995). All the posts that were generated as part of this course were archived and used as the basis of this study. Because of the nature of the research questions and the data to be analyzed, it was decided to use a qualitative analysis approach for this study.

The data, questionnaires, and interview transcripts were analyzed by one researcher and verified by a second reviewer. Where disagreement occurred a consensus was achieved through discussion.

Where names were used in the quoted communication, names were changed to protect the anonymity of the participant, but the gender of the participant remained the same.

The first step in analyzing the communications was to count the total number of communications that occurred as part of the class discussion during the eight week summer session. Then, the number of communications by each instructor and each student were totaled. The messages were then analyzed by the thematic content analysis method (Marshall, & Rossman, 1995). Question #1 was answered by using a subset of questions, a-e, answered "yes" or "no" and using all the posts of the students as the basis of decision. These questions have been outlined by Mason (1991) to evaluate critical thinking in computer communication.

26. "Did the participants make reference to previous messages?"
27. "Did they draw on their own experience?"
28. "Did they refer to course materials?"
29. "Did they refer to relevant materials outside the course?"
30. "Did they initiate new ideas for discussion?"

(pg. 114).

To answer question #2, each communication was classified as "yes" or "no." The answer to question #3 will be in narrative form as analysis if the communication indicates there was misunderstanding. For question #4 the instances of emotion were enumerated, categorized, and evaluated.

The definition of humor used in the context of computer mediated communication (CMC) follows the criteria of Chiaro, Hymes, Oring, and Palmer. Humor occurs when there is a sudden incongruity or transgresses normalcy (Palmer, 1992). This is dependent on the surrounding linguistic, geographical, sociocultural, and personal boundaries of the people for whom the humor is intended (Chiaro, 1992, Oring, 1992, and Palmer, 1994). The framing of humor is also important. A wink, a gesture, or musical accompaniment are examples of cues that are sometimes used in face-to-face communication (Hymes, 1994). In CMC these cues are more limited, but included the use of emoticons or wording to point out that something is meant to be funny.

After tabulation of the results of questions #1 through #4, the investigator sought to answer the following questions to complete the answers to the first research question.

- Did the on-line communication contribute significantly to the value of the course?
- What improvements could be made in the on-line discussion?
- What were the strengths of this type of communication?
- What were the weaknesses?
- Did students change or broaden their views?

A questionnaire with 13 questions was sent to each student participant to assist in answering these questions. Both faculty members were interviewed as part of the study.

Results

Analysis of e-mail messages

The first analysis was to determine the extent of critical thinking by the students. Out of a total number of 464 communications by the students, the vast majority referred back to a previous message. One student said, "I was surprised by the lack of agreement on a definition of ID in our seminar group. I expected the article authors to disagree, but I was not prepared for the diversity of opinion among our class members." Another example, "In response to Joanne's question, computer…." There were only seven instances when the students failed to refer to another message. An example of this was, "Sorry other ID Seminar people, but I needed to reach George and his e-mail address is not working. You can disregard this message."

Furthermore, there were numerous (40) references to the student's own experience. For example, one student stated, "We did an informal survey in one of my classes several years ago." Another student in another context related that, "I have done something like this in the classroom." The students also made frequent reference (41) to the course reading material. An example of this was, "I honestly felt that the two Heinich articles contributed little to defining the ID field," and "the Merrill article really annoyed me because…" There was also reference made to relevant material outside the course reading (17). For example, "There was an article many years ago (I have the reference somewhere), that stated..." In other instances, title and author of the references were given. One student said, "I found a paper at this WWW site: http://129.7.160.78/intro.html. I thought this was appropriate given our discussion last night." New ideas were initiated in 14 of the communications. An example of a new idea and a reference to reading outside the course reading was, "In discussing the nature of concept learning (Love and Snow) what role does primary experience and representational experience play in conceptual understanding? How do infants begin to conceptualize? Is there a transition from a behaviorist learning model to a constructivist learning model?"

It is clear from study of the communications that the answers to the five sub questions under question one are all yes. The evidence for critical thinking as manifest by the listserv communications was very strong as defined by Mason (1991).

Questions two and three were intended to discover if misunderstandings occurred as a result of using listserv for the group discussion instead of being together in the same room. There were ten instances in the communications that indicated a lack of understanding of a previous message. It is likely that all of these were misunderstandings that could easily have occurred in face-to-face discussions and were not attributable to the medium of communication itself. In each case these misunderstanding were easily and quickly corrected by an ensuing communication. An example of was, "In response to all of this, I actually did not mean the physical environment as much, rather the myriad of activities (lectures, homework, classwork) which composes the learning environment."

One of the potential weaknesses of using listserv as a means of class discussion is that it would result in dry dialogue devoid of emotion that would be found in classroom discussion. Examination of the communications revealed several instances (54) of humor injected into the discussion. Some of these were only emoticons such as, "<G>" for "grin" or ":-)" for "smile" but other messages were intended to be humorous, and they were. For example, one student asks, "The peanut gallery would like to propose a question to the powers that be." Dr. Morrison later responds, "Deborah, is she talking about us????" Another instance of humor is found when a student states, "Unfortunately it would be easier to break into Fort Knox than a Canadian school in July." Further humor is demonstrated in this response, "Jeff squirms in mock pain: Excellent retort. I am proud of my personality disorder. It has made me kind of a legend at my school. Weren't all those HyperCard stacks a form of programmed instruction? Hmm?" One last example of humor is shown in this response, "I am not a behaviorist nor a cognitivist. I am a PANIST. Consider the needs of your students and use the most appropriate methods, and it will always PAN out."

Another example of expressing emotion was this, "Behaviorist and Constructivist differ on picture perception (insert sarcasm here.)"

There was evidence that students changed their point of view because of the listserv. "Now that I have a connection, let me answer once and forever about what has dominated the previous discussions. I do have strong feelings about the comparisons, but have changed my opinion considerably....."

There were also some hurt feelings (2) revealed in the communications. Well into the seminar one student exclaims, "Please start spelling my name right!" On another occasion a student responds, "You wound me deeply. I have a great deal of respect for Dr. X."

Analysis of Questionnaire

The questionnaire was answered by six of the eight students in the class. Attempts were made to complete the questionnaire by telephone for the two non-respondents, but this attempt was not successful. Table 1 summarizes the responses to the questionnaire.

The students were unanimous in liking the listserv discussion because it gave them more time to think about their contribution. One student stated, "I liked being able to think over my answers before giving them. I felt that my level of interaction was deeper because I wasn't giving instant answers to questions posed." Another student liked using the listserv because she felt more comfortable with it than with face-to-face discussion.

Reasons for disliking the listserv discussion were that it was very time consuming, it was sometimes difficult to follow the discussion, and there was a lack of visual and auditory nuances found in a classroom discussion. One student stated, "I found that sometimes I unintentionally irritated a few people simply because they didn't have enough cues, visual etc. or auditory, tone of voice to perceive my statements in the manner in which they were intended."

The most valuable aspect of the listserv discussions mentioned by four of the six respondents was its convenience. They were not bound to appear in a class at a certain time, thus allowing them to pursue other activities and participating in the class discussion to fit their own schedule. It also eliminated geographical problems and allowed one student to participate from Canada. Another student felt the listserv was valuable because it forced constant preparation in order to participate in the discussion. One practical aspect of using a listserv mentioned was that it allowed an accurate hard copy transcript of the class discussion.

Some of the drawbacks to using listserv that were mentioned were an unfamiliarity with e-mail by one student, and difficulty in getting access to a computer terminal by another student. Two students found no drawbacks.

Improvements suggested for using the listserv included keeping the discussion on the topic, limiting the time for discussion, being sure everyone participated, and not being required to lead the discussion for a full week.

The students generally felt that the role of the faculty should be that of a facilitator in the discussion. Two students would have liked the faculty to participate more than they did. The two faculty members contributed 130 messages out of the total of 594 for the course. Two students mentioned that they thought it important for the faculty to keep the discussion focused on the topic.

When asked if they would enroll again in a class conducted using a listserv for discussion, four students responded positively, one was uncertain, and another stated, yes, if it was the only option. The majority of the students believed that a face-to-face class meeting was essential, that the class should be restricted to about 10 students, and that it probably would not work well for undergraduates. If the class were international in scope, it would be important to have background information on the other students.

Table 1. Summary of Student Questionnaire
(Not everyone responded to every question?)

Question	Response	Frequency	Example
1. What did you like about using e-mail instead of personal class interaction?	(a) gave time to reflect on answers	6	(a)"I liked being able to think over my answers before giving them. I felt my level of interaction was deeper because I wasn't giving instant answers to questions poised."
	(b) relieved uneasiness about class discussion	1	(b) "I do not really enjoy discussion classes because I am not comfortable in them and e-mailing took away some of the uneasiness."
2. What did you dislike about using e-mailing instead of personal class interaction?	(a) discussion hard to follow	2	(a) "The main component I disliked about e-mail was the lack of ease in following the discussion. ....it was hard....to remember or to tell who was sending the e-mail."
	(b) lack of visual and auditory cues	2	(b) "I found that sometimes I unintentionally irritated a few people simply because they didn't have enough cues, visual etc. or auditory, tone of voice to perceive my statements in the manner in which they were intended."
	(c) took more time	2	(c) "It seemed as if it took more time to read all the messages and I got overwhelmed. Also it limited my involvement"
	(d) personal behavior	1	(d) "...another member of the class and I had a tendency to 'gang up' on certain class members."

3. Describe the most valuable aspects of being involved in the listserv discussion.	(a) convenience of not having class meetings	4	(a) "...the convenience of not having to come to scheduled class meetings."
	(b) forced preparation	1	(b) "The self-imposed pressure to be 'prepared' at all times through keeping up and reading more than what was required."
	(c) doing something new	1	(c) "To be in on breaking new ground-doing something new....."
	(d) have accurate transcript	1	(d) "The fact that I have 100% accurate transcript of every discussion that took place in the class."
4. Describe the least valuable aspects of being involved in the listserv discussion.	(a) not accustomed to e-mail	1	(a) "I was not accustomed to sing e-mail, so the information given at each message was a distraction."
	(b) access to a terminal	2	(b) ".....I had to beg or borrow terminal time."
	(c) none	2	(c) "I don't feel there is any least valuable aspect."
	(d) took more time	1	(d) "The time involved each day to read the message. It curbed my interaction."
	(e) lack of personal interaction	1	(e) "Lack of personal (face-to-face) interaction."

5. How could the e-mail discussion be improved?	(a) make sure everyone participates	1	(a) "Make sure that everyone on the listserv participates...." (a) "It was irritating that some classmates could 'lurk' with only occasional comments and get the same grade as those of us who put a lot of effort into the class."
	(b) not lead discussion for full week	1	(b) "The responsibility for 'carrying' the discussion for a solid week was overly time consuming and could be less."
	(c) time limit on discussion	2	(c) "Put a cap on the types of replies. A lot of it was meaningless conversation at times."
	(d) need guidelines on how to respond	1	(d) "...setting up guidelines on how to respond to each other such as copying in the original comments, etc."
	(e) introduce subject & respondent	1	(e) "...emphasizing the importance of introducing the subject and respondent at the beginning of each message."
	(f) discussion got off topic	3	(f) "I think the professors involved let the discussion get off topic and somewhat out of control from time to time."
6. What role do you think the faculty should play in the course discussion?	(a) assume role of facilitator	3	(a) "The faculty should play the role of facilitator."
	(b)participate more	2	(b) "I think faculty could participate in the discussion more through posing questions, scenarios, etc."
	(c) keep on topic	3	(c) "To keep the listserv on topic."
7. How would you evaluate the faculty participation in the listserv discussion?	(a) adequate	3	(a) "Faculty participation was adequate."
	(b) less	1	(b) "Less than I would like."
	(c) excellent	1	(c) "Excellent!"
8. Would you enroll for another class using this method of class interaction?	(a) uncertain	1	(a) "I'm not sure if I would enroll in another e-mail course. It would depend on the class and the faculty involved."
	(b) definitely yes	4	(b) "Oh definitely..."
	(c) if only option	1	(c) "If it were the only option."

9. Do you think some class meetings are essential or could the class interaction be entirely by e-mail with no meeting?	(a) yes	5	(a) "I felt more comfortable knowing who I am responding to and being able to connect a face to the e-mail message."
	(b) no	1	(b) "No meetings are necessary. We got the same results whether we met or not."
10. How large of a class do you believe this mode of communication would accommodate?	(a) 6-10	4	(a) "At most 10."
	(b) 10-20	1	(b) "Ideally, 10-20 because of the number of e-mail messages that would have to read."
	(c) larger is better	1	(c) "In fact, the larger the group the richer the discussion."
11. Do you think this means of communication could be done at an undergraduate level? Please explain your answer.	(a) probably no	5	(a) "No, classes are too large."
	(b) yes	1	(b) "Yes, if the motivation can be instilled."
12. If this method of communication were done on an international and intercultural level, do you think that a certain amount of background information about the participants be necessary or desirable to help in communication? What type of information would e beneficial?	(a) need to know backgrounds	4	(a) "I think background information would be a necessity because you would most certainly encounter communication problems related to cultural assumptions and ignorance."
	(b) agree on style of writing	1	(b) " A conventional style of writing should be agreed upon and there might need to be additional discussions concerning the nature and involvement of the course."
	(c) need to be personally acquainted	1	(c) " ...I think that the members of the class all need to be personally acquainted for this to work."
	(d) possible language barrier	1	(d) "Yes, the language would be a barrier."

13. Do you have any additional comments?	(a) none	2	
	(b) enjoyed	1	(b) "I thoroughly enjoyed the listserv class last summer..."
	(c) good experience	2	(c) "It was a wonderful experience that I highly recommend to anyone looking for a class which is a little different."
	(d) need only 1 teacher	1	(d) "I think only one faculty member is needed for such a course."
	(e) have practice session	1	(e) "Have a short practice session before the first round of discussion."
	(f) have minimum & maximum number of replies	1	(f) "Have a minimum and maximum number of replies for each participant."

Summary of Faculty Interviews

Both of the faculty members believed this course was successful in achieving its purpose. Dr. Morrison stated, "So, overall I think we introduced them to some new ideas, new concepts, so they changed their…own belief systems, which is good. So, overall I think it was a success." Dr. Lowther also believed the course was successful, and to support this she stated, "From their responses we could see that they were learning…. We thought it was very successful."

The faculty were also in agreement that the great advantage of conducting the class discussion by listserv was its convenience. "It gives you the advantage in that you can participate at any time during the day and during the week," Dr. Morrison observed, and he also pointed out , "Taking the PowerBook with us, we could call (from) any place in the country and still participate and manage the instruction."

Another advantage mentioned by Dr. Morrison was that it gave the students time to form thoughtful replies. "People had a chance to let ideas gel, to read the stuff and go back and read it (again). In a conversation it comes by you one time, and that's it." Dr. Lowther observed, the students "liked the idea of being able to compose their thoughts."

Dr. Morrison pointed out an advantage not alluded to by anyone else, in that the discussion could be personalized. "You can also carry on a one-to-one conversation. So if someone disagrees with you, or they don't understand, then you have more time to tutor them or to explain your ideas, your thoughts."

The only disadvantage the two faculty members found was that the listserv discussion was very demanding. "It was 24 hours a day, 7 days a week. I mean e-mail was going continuously, and if you skipped a day, you were out of luck." Dr. Lowther said, "It was very, very time consuming to read all of the messages that the students were sending."

One suggestion to improve future classes using listserv for discussion was to limit and schedule the time for discussion. Both faculty members concurred in this. The faculty members were also in agreement concerning their advice for future classes using listserv. They would limit the enrollment to a size that is manageable for everyone. The class should be one that is content rich and where discussion is important and not dependent on lecture for presentation. The students should be adept at using e-mail, and it is helpful if they are acquainted with each other. If they are not acquainted, some biographical information would be helpful.

Table 2. Summary of Faculty Interviews

Question	Answer	Quote
What made you decide to conduct the class discussion by Listserv?	Convenience and flexible hours	" It sort of opened the classroom up and gave us the chance to hold the class without disrupting anybody's life schedules for the summer." Dr. Morrison "It was convenience." Dr. Lowther
What were the goals you had for this course?	Introduce the students to classical instructional design literature	"We wanted to introduce them to some literature that we may have just touched on in the classes but had not gone into in detail. This gave them a chance to read articles and talk and discuss the article." Dr. Morrison "We thought that to get that knowledge and understanding was to do quite a bit of reading and then to do some analysis after the reading ....then to discuss with your peers some of the ideas you had." Dr. Lowther
How would you describe your success in reaching these goals?	They learned	"They were able to carry on an intelligent...what I thought was an intelligent conversation. They changed their opinions about some of the concepts and ideas in those articles." Dr. Morrison "From their responses we could see that they were learning." Dr. Lowther

Describe the advantages of conducting the class discussion by listserv instead of in person?	Strengths: Flexible hours	"It gives you the advantage in that you can participate at any time during the day and during the week." Dr. Morrison
	Flexible location	"Taking the PowerBook with us, we could call any place in the country and still participate and manage the instruction." Dr. Morrison
	Time for thought	"But people had a chance to let the ideas gel, to read the stuff and go back and read it, where in a conversation it comes by you one time and that's it." Dr. Morrison
		"They (students) liked the idea of being able to compose their thoughts." Dr. Lowther
	Discussion could be personalized	"You can also carry on a one to one conversation. So, if someone disagrees with you or they don't understand, then you have more time to tutor them or to explain your ideas...your thoughts." Dr. Morrison
	Convenience	"It was convenience." "Students really liked being able to stay home." Dr. Lowther
	More accountable	".....it was in written form made them more accountable for what they say." Dr. Lowther

Describe the disadvantages of conducting the class discussion by listserv instead of in person?	Weaknesses: Demanding in time	"Instead it was 24 hours a day 7 days a week. I mean e-mail was going continuously. And if you skipped a day you were out of luck." Dr. Morrison
		"It was very, very time consuming to read all of the messages that the students were sending." Dr. Lowther
	Misinterpret e-mail	"...sometimes you misinterpret the e-mail." Dr. Lowther
What problems did you experience using this means of communication?	Referring to past statements	" The greatest problem was knowing how to refer to a past statement." Dr. Lowther
	Learning to summarize	"Learning how to summarize what someone said without loosing the richness of it without having to paste in the whole statement." Dr. Lowther
How could the e-mail discussions have been improved?	Suggested time frame	"I think that in the future we need to look at ways of limiting that. Like...We've talked about Monday, Wednesday, Friday, or Tuesday, Thursday, Sunday are the only days you can post responses" Dr. Morrison
	Guidelines	"There needs to be some guidelines on the length of what you can do." Dr. Lowther
How, as an instructor, did you evaluate each participant's contribution?	Twenty percent of grade was discussion	"We sort of kept an anecdotal reports or journal during the week as to who was communicating, what was going on and who was changing ideas." Dr. Morrison
		" We would just watch. And see what was going on." Dr. Lowther
		"We had an overall assessment to where they turned in papers." Dr. Lowther

Do you think the listserv is suitable for any class or is it limited to certain types of instruction? If so, what are the limitations?	Adapting the listserv to: Discussion class:	"Discussion type class seems best suited for Listserv." Dr. Morrison "I think it has to be a class that is content rich." Dr. Lowther
	Lecture class:	"In say a typical lecture...standing up lecturing and students listening, taking notes, I think you could have the listserv going as a discussion of the lectures. Particularly if the lecturer would post his or her notes or some questions. Then you could have the students discuss those questions related to the lecture."
Would you consider conducting this class entirely by Listserv?	We did that	"Well, that is sort of what we did with this one. Since it was discussion that worked out just fine." Dr. Morrison "Yeah, we did it with this one." Dr. Lowther
How large of a class would this listserv be suited for?	There is an upper limit	"I think there's probably an upper limit. If you got above 20 it may just get too humongous." Dr. Morrison "I think you could possibly do it with 15." Dr. Lowther "If you had a class of 300 you might want to have many separate individual listserves." Dr. Morrison "...with 300 people you would have too many lurkers. There is no way they could all participate. ...but you could have specific groups that had to actively participate during specific times in the semester while the rest are lurkers." Dr. Lowther

How much participation by the teacher should occur?	Participant	"You can be a participant and join in the discussion and present your points of views, and questions other people's point of views." Dr. Morrison
	Facilitator	"Or you can basically settle back and do nothing until someone gets out of hand." Dr. Morrison "I saw my role as a guide...a mentor. A facilitator not an instructor." Dr. Lowther
What is the role of the teacher in leading the discussion?	Multi-faceted	"It's multi-faceted." Dr. Morrison
All the participants were computer competent. What prerequisite should a student have for this course? to what extent must the student be computer competent?	Competent with e-mail	"Well, they have to be pretty competent with e-mail." Dr. Morrison "They need to know how to use e-mail. Save a document, create it, send it, and be able to open it and reply." Dr. Lowther
If you were to conduct this class again and use the listserv for the discussion, what would you do differently to improve the experience for the student?	List the times	"I think the big thing that we will do this summer is to list the times that you can post." Dr. Morrison "I think a little more structure.....a little instruction about e-mail. Some e-mail etiquette maybe." Dr. Lowther

Summary and conclusions

The listserv communications that occurred during the course of this seminar clearly demonstrated that this method of discussion was successful for the purpose of this class. Thematic analysis of the posts and application of Mason's (1991) criteria for evidence of critical thinking in computer communications gave evidence that the students were critically analyzing and synthesizing the course reading material.

Besides critical thinking, the messages also revealed the emotions of humor, hurt feelings and sarcasm although the participants felt that this was not comparable to the subtle auditory and visual nuances present in face-to-face discussion. Misunderstandings, which were infrequent, were due to content of messages and not due to the electronic media being used.

This method of class discussion had an advantage over face-to-face discussion in that it allowed the participants greater opportunity to consider their responses before contributing their reply. It also had the advantage of convenience because the participants did not have to be in a class at a certain time or in a certain place.

The main disadvantage in using listserv for discussion was that it was very demanding and time consuming. Another drawback mentioned by several students was that they missed the visual and auditory nuances present in a face-to-face discussion.

In future courses using listserv, scheduling at time for the discussion would help to solve the problem presented by a continuous flow of communication. Familiarity with the use of e-mail and ready access to a computer are important prerequisites for students in the course. It is also important for the faculty to keep the discussion focused on topic and to insure everyone participates while not allowing a few students to dominate the discussion.

Undoubtedly the availability of listserv for use in class discussion will make it possible to extend the availability of some courses of study and to enrich them as well by providing greater access to educational opportunities. As computer usage by students increases and availability of avenues of communication broaden, the use of this media for educational purposes will increase. It is important for educators to take full advantage of the potentialities of the advances in communication.

Although the use of listserv was successful for the purpose of this seminar, there are still many questions regarding the use of listserv that would occur in other classes. For example, what is the optimum class size for use of this media? What are the upper and lower limits of enrollment in such a class? Do the instruction methods of the faculty need to be adapted to this change in method of communication, and if so, what are they? Are some students better suited for listserv discussion while others face-to-face discussion? If so, how do we determine this? Could some subjects be improved by listserv discussion? For example, a class in political science might benefit from participation of students in other countries. All of these questions need further research in order to make the best use of this method of communication.

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Computer Assisted Automatization of Multiplication Facts Reduces Mathematics Anxiety in Elementary School Children

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Abstract

Fourth grade elementary school children exhibiting High and Low mathematics anxiety were trained on multiplication facts using a computer program designed to bring their performance to the automaticity level. Mathematics anxiety, measured by the Mathematics Anxiety Rating Scale - Elementary version (MARS-E), was assessed before and after the students demonstrated automaticity level performance on the multiplication facts. Results showed that all of the students automatized the multiplication facts using computer training. Students in the High Anxiety group averaged the greatest improvement in performance, and were indistinguishable from the performance of the Low Anxiety group by the end of the automaticity training. The High Anxiety girls, but not the High Anxiety boys significantly reduced their mathematics anxiety ratings. No significant change in mean anxiety ratings were detected for students in either of the Low Anxiety groups or the Control groups. Results of the experiment indicate that both High and Low Anxiety boys and girls achieved automaticity level performance of multiplication facts using CAI training, and training of multiplication facts to the automaticity level resulted in significant reductions of mathematics anxiety ratings. These results provide support for the position that mathematics anxiety may result from a failure to learn or inadequate preparation in the mastery of fundamental skills. Implications of these findings for mathematics instruction and curricula development, in light of the NCTM Curriculum standards are discussed.

Mathematics anxiety has been shown to be a substantial problem for many students in the United States, Canada, Great Britain, Belgium, and other parts of the world (Lewis, Hitch, & Walker, 1994; Nimier, 1993). Studies have shown that a disproportionately greater percentage of females, compared to males, exhibit mathematics anxiety characteristics, and that mathematics anxiety may be responsible for detrimental and narrowing influences on the vocational and career choices of both men and women (Schneider & Nevid, 1993). Mathematics anxiety has been a significant problem for schools. While children do not begin their education with mathematics anxiety, many of them leave the educational system with it (Reyes, 1984). Despite the variety of views and models which have been proposed to explain mathematics anxiety (e.g. Dreger & Aiken, 1957; Dutton, 1954; Mandler & Sarason, 1952)., research has been less productive in identifying the causal factors which surround it (Hembree, 1988; 1990).

Consideration of the relationship between instruction and mathematics anxiety is especially timely considering the recently proposed NCTM Curriculm Standards (1989), which seek to greatly reduce the role of drills and rote mastery tasks in favor of making mathematics 'meaningful' by emphasizing the conceptual and contextual aspects of mathematics education. For some authors (Bloom, 1986; Carnine, Jones, and Dixon, 1994; Resnick & Ford, 1981), students' development of negative attitudes and frustration toward mathematics may result from the failure of schools to promote the learning of fundamental mathematics skills to mastery levels. The NCTM proposal has not been uniformly endorsed as the most suitable approach to mathematics reform (Carnine, Jones, and Dixon, 1994). Indeed, the controversy surrounding drill and practice has waged unresolved for quite some time (e.g. Bloom, 1986; Bryan & Harter, 1899; Carnine, Jones, and Dixon, 1994; Resnick & Ford, 1981; Reeve, 1944). Some authors have suggested that the dilemma surrounding student mathematics competencies may have been inherited as a by-product of the math revolution of the 1960s which de-emphasized drill and practice (Resnick & Ford, 1981), while others (Carnine, Jones, and Dixon, 1994), have argued that the goals and objectives proposed in the NCTM curriculum standards (1989) are virtually the same as those endorsed during the mathematics revolution of the 1960's.

The importance of drill and practice and its relationship to the acquisition of expert performance has been a topic of considerable interest (Salisbury, 1990; Salisbury & Klein, 1988). At the beginning of the 19th century, Bryan and Harter (1899) reported that the automatization of knowledge brought about by repetitive practice is instrumental, not only in the acquisition and refinement of new skills for novice learners, but is the foundation for the mastery level performance shown by experts. The role of the school system was seen as providing the instructional setting and opportunities for students to develop subject matter expertise through mastery of it's details. Bloom (1986), however, notes that children come to school poorly prepared to meet the challenges of learning, and that school systems, in general, are poorly equipped to be even less than moderately successful in developing mastery level subject performance among it's students. Thus, given the current de-emphasis on drill and practice activities in public school mathematics education, it is reasonable to anticipate that an eventual outgrowth of this failure to provide adequate essential training in basic mathematics skills would be manifested in the form of mathematics anxiety. Mathematics anxiety, therefore is viewed as resulting from a basic lack of knowledge, rather than the result of a pre-existing anxiety disposition, as has been suggested by others (e.g. Mandler & Sarason, 1952; Sarason, 1980).

The use of computer assisted instruction (CAI) offers an excellent vehicle for the assessment of the impact of mathematics drill and practice activities in elementary school children and it's relationship to mathematics anxiety. CAI technology could hold a great deal of promise for providing mathematics instruction to students who suffer from mathematics anxiety (Harris and Harris, 1987). In addition to offering individualization and flexibility, CAI based instruction is impartial, reinforcing, appeals to student interest, and also offers a sense of privacy for students who are anxious or self-conscious about their performance.

A number of recent investigations have examined the role of automaticity in learning by evaluating the performance characteristics of students trained on a particular task or skill to a level defined as 'automatic.' For example, Hasselbring, Goin, and Bransford, (1987; 1988) using computer based automaticity training, found that learning disabled children were able to master addition facts to the same levels as non-learning disabled control children who were given regular classroom instruction alone. Similarly, students with 'mild mental handicaps' benefited, significantly from automaticity training of addition and subtraction facts using a computer assisted 'drill-and-practice' instructional form (Lin, Podell and Rein, 1994; Podell and Lin, 1992). Other studies have examined the pivotal role played by automatization of performance in areas such as spelling (Ormrod & Lounge, 1990), and reading (Nicolson & Fawcett, 1990).

This study examined the relationship between 4th grade students' mathematics anxiety before and after automatization of multiplication facts, using a CAI drill and practice format. It was expected that students exhibiting high mathematics anxiety, but not low anxiety, would significantly reduce their mathematics anxiety ratings following CAI training of multiplication facts to the automaticity level. Further, it was predicted that high mathematics anxiety students would require significantly more trials to achieve the automatization of multiplication facts than students exhibiting low mathematics anxiety.

Subjects

The subject pool consisted of the total number of 4th grade students enrolled in a single public elementary school located in the Pacific Northwest. Fourth grade students were selected for the experiment because pilot research showed that these students were still in the initial stages of learning multiplication facts, and far from achieving automaticity. Some students did not participate in the study due to parental preference, and the data for other students was not included because the information was incomplete. A grand total of 63 students (81%) completed the experiment. There were 33 boys (52%) and 30 girls (48%). The individual student ages were evenly distributed across classrooms. The average age for boys was 10 years - 1 month, and for girls, the average age was 10 years - 0 months. Students receiving support through remedial services programs were not included in the experiment to further control the characteristics of the population sample.

Instrumentation

The primary instruments utilized in the investigation included the Math Builder Program© (Wittman, 1994), and the Mathematics Anxiety Rating Scale-Elementary School Level (MARS-E), (Suinn, Taylor, & Edwards, 1988). The Math Builder Program© is a CAI program developed by the first author using the Hypercard©

authoring system and is designed to provide drill and practice in basic mathematics facts. The program is considered 'user-friendly' because individual students are capable of operating the program following only brief initial instruction in its use, and distant supervision thereafter. Detailed information concerning the Math Builder Program as well as instructions for operation are available from the author (Wittman, 1996). The MARS-E (Suinn, Taylor, & Edwards, 1988) is a 26 item rating scale designed to measure the mathematics anxiety construct in 4th, 5th, and 6th grade elementary school children. The MARS-E was normed on 1,119 elementary school children randomly selected from 6 different school districts across the State of Colorado. Reliability estimates for the MARS-E, using the Cronbach's alpha statistic, was found to be .88. Construct validation data indicates that the MARS-E correlated significantly (-.31) with the Stanford Achievement Test, Mathematics Test, with component correlations for individual math skills (ie. applications, computations, concepts) ranging from -.26 to -.29. The MARS-E, and the remainder of the family of MARS tests (i.e. MARS, MARS-A) are considered the field standards in the assessment of mathematics anxiety.

Procedure

Two experimenters were available to work with the students throughout the spring term of the school year and terminating when the individual students either met the designated performance criterion, or the last week of the school year arrived. Individual students and teachers were not informed about the specific purpose of the investigation until it's conclusion. A group administration of the MARS-E was conducted with the students during regular classroom hours. Following a brief introduction each student was given a MARS-E protocol. The actual administration of the MARS-E took approximately 20 minutes for each individual classroom.

Following the pre-test, a total of twenty-four students were randomly selected from the upper (n = 12) and lower (n = 12) thirds of the mathematics anxiety distribution, forming 2 experimental groups: High Mathematics Anxiety, Low Mathematics Anxiety. Each of the two groups was subdivided evenly with respect to gender (6 male, 6 female) as well as mathematics aptitude based on their pre-existing 4th grade Metropolitan Achievement Test (MAT) results. An additional 12 students (6 male, 6 female) were randomly selected from the remaining pool of subjects to serve as a Control group for possible changes in MARS-E ratings resulting simply from the passage of time. Students in the Control group did not participate in the automaticity-training portion of the experiment. Any student whose overall MAT mathematics aptitude score was found to be in excess of 1.0 standard deviation above or below the mean for their particular group was dropped from the study and a different subject was selected from the pool of remaining student candidates.

Day 1

On Day 1 of CAI training, students were introduced to the Math Builder Program individually by the experimenter to ensure a thorough understanding of the program and it's operation. The experimenters were blind to each subject's mathematics anxiety condition throughout the course of CAI training and testing, as well as during the post-test administration of the MARS-E. For the purpose of the present investigation students worked exclusively on the multiplication component of the Math Builder Program.

Level-I Problems

After familiarization had been completed, each student was allowed the opportunity to complete 3 Level-I Multiplication Problems for practice. Thereafter, each student was given daily practice on Level-I problems until a criterion score of 29/30 correct responses for each problem had been achieved on two consecutive daily trials. Level-I problems consisted of 30 multiplication facts were selected from the standard matrix of multiplication facts. Selection was narrowed to include only one fact associated with any fact-pair (e.g., only one form of the problem pair 3 x 2, or 2 x 3, selected at random was used), the limited use of fact-twins (e.g., 5 x 5, or 6 x 6; only 2 of the 10 available twins were selected and used in the experiment), and the elimination of 0 and 1 number facts from consideration (e.g., 3 x 0, or 4 x 1). Information concerning the specific multiplication facts used in the experiment is detailed in Wittman (1996). The same multiplication facts were used throughout the entire course of the experiment, however, the order of problem presentation was randomized prior to each session. Information concerning the number of correct answers was recorded from the student's score card at the end of each session and entered into a spreadsheet. Once a student met the criterion score of 29/30 on the Level-I problems for 2 consecutive sessions, the student was advanced to the Level-II problems at the next scheduled training session. The requirement of 2 consecutive near-perfect sessions for the Level-I problems was designed to meet the criterion established by Hasselbring, Goin, and Bransford (1988), that students have an established declarative knowledge base for the recall of mathematics facts from memory. Students who were observed using an obvious procedural strategy during the Level-I phase of the Math Builder Program were gently reminded to answer on the basis of recall, and to 'guess if necessary,' if uncertain about the answer to a problem. The criterion of 29/30 correct was adopted for the experiment instead of the more rigorous 30/30 because pilot data indicated that most of the students in the tryout made at least one 'careless error' during any given individual session.

Level-II Problems

The Level-II component of the Math Builder Program was designed to bring the level of student performance of basic multiplication facts to a level defined as automatic. According to Logan (1985) simply knowing the answer to a problem is different than automatization of the response. In the case of automaticity, the qualifying criterion refers to a specific 'effortless' property of performance. In research practice, the parameters concerning what constitutes the automatization of mathematics facts have been variable, ranging from one or three seconds per problem, (Wiebe, 1988; Hasselbring, et al, 1987; 1988). Initial test trials using the Math Builder Program was largely consistent with these parameters. Pilot testing showed that the 3-second interval comfortably reflected the student's uninterrupted movement of the mouse to the response button immediately after the initial presentation of the multiplication fact on the computer. Any attempt by students to problem-solve a multiplication fact using a strategy other than memory retrieval (e.g. counting, adding on) resulted in reaction times that were always 4 seconds or considerably longer. In practice, the students continually worked harder to earn increasingly faster reaction times, despite the 3 second criterion, and the majority of the students were responding to multiplication facts within one or two seconds per problem.

The dependent variables to assess the development of automaticity consisted of assessing mean changes in student reaction times to individual multiplication facts across sessions, as well as a daily assessment of the overall number of responses which met the criterion set for automaticity across problems. In order to meet this latter objective, students' scores for each daily session were converted to automaticity quotients (Wittman, 1996), then transformed to logarithms. The formula for the automaticity quotient is given by the following:

$$(a/\text{non-a}) \times 100 = aq$$

where a = the number of correct responses in a given daily session which occurred in 3 seconds or less, and non-a = the number of responses which did not meet the 3 seconds criterion or were simply incorrect.

Thus, for a fixed number of 30 daily problems n = 30

for an outcome < 50% automaticity	(5/25) x 100 = 20	LogAQ (20) = 1.30
for an outcome = 50% automaticity	(15/15) x 100 = 100	LogAQ (100) = 2.00
for an outcome > 50% automaticity	(25/5) x 100 = 500	LogAQ (500) = 2.69

The LogAQ characterizes the development of automaticity as a monotonically increasing linear relationship between the number of successfully automatized versus non-automatized problems found in a given daily session. The LogAQ transformation compacts extreme scores into a more uniform distribution to better meet the requirements for statistical tests (Howell, 1993).

For the Level-II sessions, students were seated individually before the computer and performed under conditions identical to those used for the Level-I condition. The Level-II program began with an initial set of instructions emphasizing the importance of accuracy and speed of response. Students were reminded that the goal of Level-II would be to maintain accuracy while responding with increasingly faster reaction times to each problem presented. The experimenter uniformly encouraged students to "beat your best time" throughout the Level-II sessions. Level-II problems consisted of a randomized list of the same multiplication facts used in the Level-I series. The problems, and the corresponding response buttons were randomized across presentations to ensure that the students' learning reflected genuine recall of the mathematics facts, and not memorization of the pattern of answers. As noted in the description of the Level-II problems, students received visual feedback about their reaction time for each problem they solved correctly. Criterion for automaticity at Level-II, evidenced by student reaction times of 3 seconds or less to each of the 30 individual multiplication problems for 3 separate session presentations, was recorded and entered into a spreadsheet at the end of the day. Students practiced all 30 of the multiplication facts until the criterion for each of the 30 multiplication facts had been met.

MARS-E Post-Test

Once each of the 24 students achieved criterion performance on the Level-II multiplication facts, the MARS-E was readministered. The students who did not participate in the CAI portion of the experiment were simply readministered the MARS-E in their classrooms.

Results

The results of the experiment provided confirmatory evidence for the primary research hypotheses. The students achieved automaticity level performance as a result of CAI training, which, in turn, resulted in significant reductions in mathematics anxiety ratings for students in the High, but not Low Mathematics anxiety groups.

Analysis of Demographic Information

Independent analyses of the subject population by MARS-E Pre-Test and by (CTBS) Mathematics Achievement failed to identify any significant differences between groups as a function of gender, classroom placement, or the interaction between these variables (all p's > .05). Detailed information concerning these results is available in Wittman (1996).

Analysis of pre-treatment variables

MARS-E pre-training scores. A exploratory 3 x 2 ANOVA with groups (High Anxiety, Low Anxiety, Controls) and gender (Boys, Girls) for the MARS-E pretest variable demonstrated a significant main effect of anxiety condition (F (2, 27) = 44.429, MSE = 89.89. p < .0001). Analysis of the main effect of anxiety using the Newman-Keuls statistic demonstrated significant differences between each of the anxiety conditions and the control groups (all p's < .05), verifying that the deliberate selection procedure of the 2 anxiety groups and the random selection of control subjects resulted in clear differentiation on the mathematics anxiety dimension. Comparison of these 3 groups to the normative data provided by Suinn, et al. (1988), demonstrated that the mean ratings for students in the High Anxiety condition corresponded to the normative group scoring at the 95th %tile (+1.5 SD), the students in the Low Anxiety condition were found to be at or below the 10th %tile of Suinn's distribution (-1.5 SD), and the scores of the students who were selected at random to occupy the Control condition clustered closely around the 50th %tile. A similar 3 x 2 ANOVA calculated to examine the relationship between mathematics achievement variable and the MARS-E scores, demonstrated a significant main effect of anxiety condition (F (2, 27) = 8.05) p < .001). The main effect of gender (F (1, 27) = .018, ns) and the interaction between gender and anxiety condition (F (2, 27) = .064, ns), however, did not prove statistically significant. A Newman-Keuls analysis of the main effect of anxiety group demonstrated that the High Anxiety student group manifested significantly lower CTBS total mathematics achievement scores than students in either the control group or in the Low Anxiety condition (p's < .05). Students in the control group, did not differ significantly in math achievement, compared to the students in the Low Anxiety condition.

Differential performance of the anxiety groups

Analyses of student performance across the course of the experiment showed that students in the High Anxiety condition improved their knowledge and proficiency in solving basic multiplication facts, significantly, as a function of drill and practice. While the High Anxiety students' performance was initially inferior compared to their Low Anxiety counterparts, beginning with the Level-I problems, the differences were greatly reduced across the Level-II sessions, and eventually eliminated. The performance of the students in the Low Anxiety condition, while superior to the High Anxiety students on Level-I problems and across the course of the Level-II problem series, became quickly asymptotic, after which the High Anxiety students narrowed and eliminated the gap. These results are described in detail in Wittman (1996).

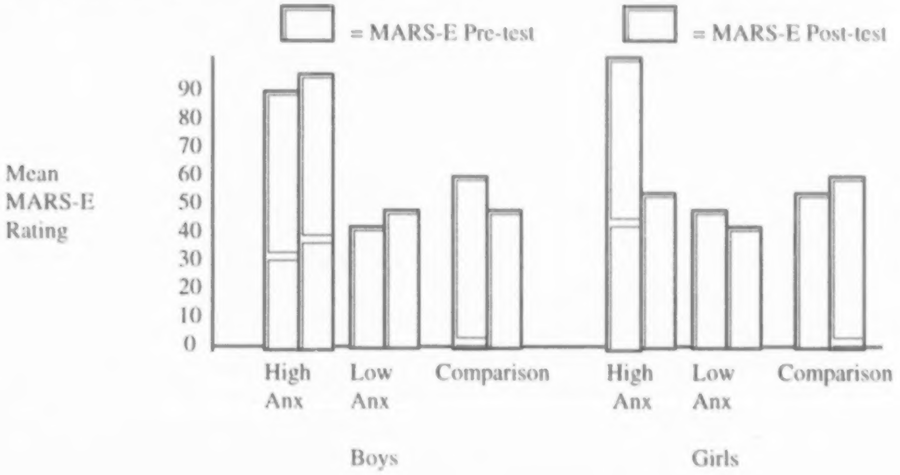
MARS-E Test Results

The results of the MARS-E pre and post test ratings were analyzed using a 2 x 3 x 2 split plot factorial ANOVA with gender (boys, girls), anxiety condition (High Anxiety, Low Anxiety, Comparison), test session (Pre-test, Post-test), and the interaction between these variables serving as factors. Results of this analysis revealed a significant main effect of anxiety condition (F (2, 27) = 24.41, MSE = 245.08, p < .0001), and the 3-way interaction between gender, anxiety condition, and test session ($F\ (2, 27) = 3.64$, $MSE\ = 210.25\ p\ < .039$). Neither the main effect of gender, or any of the other interaction terms approached statistical significance (F's < 1).

Breakdown of the results of the main effect of anxiety condition using studentized range t-score statistic, and the MSE for subjects error term from the main analysis showed that, overall, the students in the High Anxiety group generated significantly higher overall MARS-E ratings than the students in the Low Anxiety group ($M\ \text{diff} = 34.72$, $t\ (1, 27) = 7.27$, $SEM\ = 4.77$, $p\ < .01$), and students in the Comparison Group ($M\ \text{diff} = 24.43$, $t\ (1, 27) = 5.12$, $SEM\ = 4.77$, $p\ < .01$). The Comparison Group's performance was intermediate in relation to the High and Low Anxiety groups and did not differ significantly from the Low Anxiety group, ($M\ \text{diff} = 10.29$, $t\ (1, 27) = 2.15$).

Results of the triple interaction (figure 1) demonstrated that the relationship between anxiety condition and pre-test versus post-test performance, primarily reflected a significant decrease in pre-post test MARS-E ratings for the girls in the High Anxiety group {$F\ (1, 27) = 9.14$, $p\ < .01$). None of the other comparisons within gender and anxiety conditions, across the pre versus post test intervals came close to reaching statistical significance (all p's $> .05$)}.

Figure 1. Graph of the gender x anxiety condition x pre/post-test MARS-E ratings: (H = High Anxiety, L = Low Anxiety, C = Comparison Group).



Comparisons for girls at the pre-test interval showed that High Anxiety girls reported significantly greater mathematics anxiety than the girls in either of the Low Anxiety or Control group conditions (p's $< .05$). The girls in the Control group, did not differ significantly from the girls in the Low Anxiety condition. At the post-test intervals, however, the High Anxiety girls reduced their mathematics anxiety ratings to a level which did not differ significantly from the control girls ($p < .05$). The ratings of the High Anxiety girls were significantly higher than the Low Anxiety girls ($p < .05$).

Similar analyses of the triple interaction for boys revealed significant differences between the anxiety and control conditions at the pre-test as well as at the post-test intervals. The nature of these results was explored using the studentized range statistic and the pooled between MSE terms drawn from the main analysis. At the pretest interval the results showed that the boys in the High Anxiety group reported significantly greater mathematics anxiety ratings than students in either the Low Anxiety group or the Control group, and the mathematics anxiety ratings for students in the Control group were intermediate in relation to the High Anxiety and the Low Anxiety groups. The same comparisons between anxiety conditions for the boys at the post-test intervals showed that the boys in the High Anxiety group continued to report significantly higher mathematics anxiety ratings than the boys in the Low Anxiety and the Control groups (p's $< .01$), however, the latter two groups no longer differed significantly from one and other.

Analysis of the triple interaction for boys and girls within each anxiety condition, across test sessions confirmed the results of previous analyses with respect to the performance of students in the High Anxiety conditions by showing that only the girls in the High Anxiety condition significantly lowered their MARS-E ratings between the pre-test and the post-test ($p < .05$). Similar comparisons examined for the remaining groups were not statistically significant (all p's $> .05$).

Discussion

The results of the experiment provided confirming evidence in support of the main research question; a reduction of mathematics anxiety was achieved among girls in the high anxiety condition presumably as a result of automatization of multiplication facts using the CAI program. Specifically, the girls in the High Anxiety condition evidenced a significant reduction in MARS-E ratings at the post-test, compared to their pre-test ratings. At the post-test, the High Anxiety girls' mathematics anxiety ratings were indistinguishable from a group of control girls who's performance was found to be within the average range, compared to Suinn, et al's (1988) MARS-E normative sample. Thus, a group of girls who initially reported clinically debilitating levels of mathematics anxiety, at the pre-test (ie. 95th %tile), subsequently changed their mathematics anxiety ratings to the 'average range' (50th %tile), as a result of the CAI intervention and automatization of multiplication facts.

While these results are encouraging, it is not entirely clear why the significant decrease in mathematics anxiety rating was confined purely to the girls in the High Anxiety group. Since the pattern of performance of the boys and girls in the High Anxiety group was statistically identical across virtually all of the experimental measures, it would seem reasonable to expect that parallel performance should have been obtained with respect to the mathematics anxiety variable, as well. Indeed, given the prevailing 'masculine attitude' toward male superiority in mathematics one would expect that boys would be more likely to understate, than overstate their mathematics anxiety ratings, resulting in a built-in degree of statistical regression of scores across the course of the experiment. Instead, however, the High Anxiety boys appeared to be quite willing to report their anxieties about mathematics and maintained this position from pre-test to post-test. A second and more parsimonious explanation for the differential results could reside in the very small number of boys making up the High Anxiety group who actually completed the experiment. The subject mortality rate of 50% is substantial. It would be difficult to draw further conclusions concerning the mathematics anxiety variable for these particular students with a subject pool of only 3 boys making up the High Anxiety condition.

Neither the students in the Low Anxiety or the Control groups demonstrated a significant reduction in mathematics anxiety ratings between the pre and post test intervals and this finding is not surprising. Since the average MARS-E ratings of the Low Anxiety group clustered around the 10th percentile of the normative distribution, any substantial improvements that they might have made in terms of MARS-E ratings would have easily been masked by 'floor effects.' Since students in the Control condition did not experience the CAI portion of the experiment, changes in mathematics ratings would not be expected. Perhaps of even greater importance, however, was the observation that none of the students showed increased mathematics anxiety ratings resulting from the CAI drill and practice sessions. Thus, the question concerning whether routine drill and practice activities might be somehow anxiety inducing, appears unlikely, viewed from the standpoint of the performance of the present 4th grade student group. The results of the experiment provided encouraging evidence to support additional efforts in the study of the relationship between anxiety variables and automaticity.

The results of the experiment hold important implications for elementary school mathematics instruction, particularly in light of the 1989 National Council of Teachers of Mathematics (NCTM), curriculum standards. In addition to the reduction of mathematics anxiety, other results of the experiment (Wittman, 1996) showed that student performance on multiplication facts was substantially improved using the Math Builder program. This improvement was observed regardless of whether individual students exhibited High or Low Anxiety levels. The controversy surrounding the best approach to mathematics instruction, (ie. drills versus conceptual) is beside the point. In order for students to make mathematics a skill to be used meaningfully for problem solving, students need to automatize the facts and routines to the degree that conceptual processing of information occurs independently of these basic processes. Students' whose mathematical problem-solving performance is hindered by the continual need to review facts and procedures will learn to view mathematics as an anxiety provoking experience. Providing students with the opportunity for sufficient drill and practice will empower them with the capacity to go beyond the basics; a process of drill and discovery.

The results of the experiment provide support for the position that mathematics anxiety does not necessarily exist as a personality characteristic predating and independent-of mathematics performance. Similar to Tobias (1985), our position suggests that mathematics anxiety develops as a logical reaction to insufficient learning of fundamental skills. Instructional programs, and especially CAI programs, which emphasize training student performance on basic number facts to the automatic level will provide students with the skills they need to become confident mathematicians.

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Implementing intergenerational electronic communications into the curriculum: Results of a year-long case study featuring second graders and senior citizens.

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Project Introduction

In early 1995, the researchers began working with a second grade teacher and a group of senior citizens on a long-term e-mail-based project designed to involve the seniors in the education of a second-grade class. After an extensive planning period, the project actually started in August, 1996, and the initial phase concluded in May, 1997. The purpose of this paper is to provide a description of the activities and results of this year-long intergenerational electronic communication project.

Project Goals

The fundamental purpose of the project was for two distinct generational groups in the same geographical community to get involved in a year-long dialogue featuring discussion topics generated by the second grade teacher. These topics were planned to integrate with regular scheduled student activities in the classroom. A key expectation was that as the seniors brought outside experiences and recollections into the second grade classroom, the students would come to see the senior community as part of their own, but also that the seniors would come to understand and support the school community. Consequently, it was also a goal of the project that face to face meetings between the two groups would also occur. These face to face opportunities were identified as not only the natural outcome of the process, but a necessary part of creating an intergenerational community building experience. One of the key insights of this project was that the Internet could serve to lower barriers between communities that were geographically close, but socially unconnected, i.e. generationally distant, and enable such meetings to happen.

The researchers used Erikson's psychosocial theory of development as a theoretical framework for understanding the interactions between the two groups, and found it to be an extremely productive for that purpose. We also framed our investigation in terms of our goal of creating an "intergenerational community." In this context, "intergenerational" refers to an attempt to bond members of two different generations for the purpose of achieving a goal which reflects the commonality of both. "Community" refers to a physical or virtual collection of members whose existence is predicated on common interests, beliefs, or space. The goals implied in the two terms provided the researchers with a basis for observing and describing how the project, through the use of the Internet, was beneficial in providing a common experience for both groups. In addition, Erikson's psychosocial theory on development was used in generally assessing the distinctive differences and potential for connecting and communicating ideas.

Erikson's Psychosocial Theory of Development

Erikson's psychosocial theory of development was developed as a way of adding on to Freud's theory of psychosexual development (Miller, 1993). Unlike Freud's theory focusing on the stages of child development, Erikson attempted to develop a theory which addressed a life-long developmental process featuring key points of psychological crises that needed to be resolved as one matures through the eight stages. The crises points were labeled as follows and roughly correspond to stages of maturity (Erikson, 1980).

Psychological Crises	Developmental Stage
Stage 1- Trust vs. Mistrust	Infancy
Stage 2- Autonomy vs. Shame	18 months to 3 years
Stage 3- Initiative vs. Guilt	3 years to 6 years
Stage 4- Industry vs. Inferiority*	6 years to 12 years
Stage 5- Identity and Repudiation vs. Identity Diffusion	Adolescence
Stage 6- Intimacy and Solidarity vs. Isolation	Young Adulthood
Stage 7- Generativity vs. Self-absorption	Adulthood
Stage 8- Integrity vs. Despair*	Aging

* Stages representative of the two groups involved in the project.

Erikson's Psychosocial Theory Characteristics Of The Two Project Groups

Although, Erikson's stages included eight monumental instances of development, this study involved groups who are primarily entering the fourth (2nd graders) and eighth (seniors) stages of Erikson's model. In stage four, industry vs. inferiority, children enter the larger world of knowledge and work. Learning about others, things, and skills help make up their identity. Likewise, it is very important that guidance be given to help alleviate frustration and failure. Seniors have entered stage eight which is characteristic of the conflict between integrity and despair. They have begun the process of accepting the limitations of life, and have viewed their success in terms of sharing a larger history that includes previous generations. A sense of commitment to the future takes the shape of increased interest in doing positive things not for one's own gratification, but for the sense of leaving a legacy. This legacy includes a sense of history that is uniquely needed in the development of the children operating in the fourth stage. Conversely, the seniors need the reinforcement from children to help alleviate the feelings of despair which are often characterized as regret for what one has not done in one's life and disgust with one's self and fear of one's death.

Erikson identifies community as a central theme existing in both the 4th and 8th stages concerning the radius of significant relations (Miller, 1993). In the industry vs. inferiority stage children extend their concept of belonging outside of the basic family to include membership in a community. This includes the psychosocial modality of making things with others together and identifying with those accomplishments. In the 8th stage, community has been extended to include a more general membership to mankind. This includes a special kinship with other 8th stage members who can share a sense of survival as well as a sense of wisdom-gathering that must be handed down to future generations. The need for this intergenerational connection creates both a need to connect as well as increased feelings of alienation. This wisdom is perceived by the 8th stage members to be important yet unappreciated by members of the other stages of psychosocial development.

Second Grade Activities Concerning Community Concepts

Second graders in school are typically in the process of learning about community and identifying community members. This includes examples of communicating with other second graders internationally to experience what other communities are like throughout the world. In addition, the kids are learning about what makes up a member in their own communities. An interesting method for teaching children community involves lessons that attempt to characterize members by describing what they do, such as little league coach, preacher, fireman. One of the apparent negative results in this teaching method is children learning that active careers as being the most important factor in determining members of the community. Seniors have a tendency to be ignored due to the fact that they are no longer active members providing a visible function in the community. Attempts at introducing concepts of family with community can be adopted to foster a connection with grandparents and seniors in the community.

Components of the Local Internet Community

The Blacksburg Electronic Village (BEV) has been constructed to provide the citizens of Blacksburg with tools to foster community involvement. It essentially provides internet access to a large number of local community members. One of the most innovative concepts of the Blacksburg Electronic Village is the ability to provide a vehicle in which local community members can interact, express concerns, provide information and services for each other with the end result being an electronic local social interaction. Rogers (1983) identified this very concept as being an innovation that could bolster and redefine community membership in the information age. One of the most active user groups in the BEV community is the senior citizen user group. The purpose statement of the senior citizens group in BEV is as follows:

> BEV-Seniors have the primary goal of enhancing computer communications among senior citizens by improving their ability to use computers and BEV software. On the BEV-Seniors Listserv and on the BEV "Seniors Information Page" we also:
>
> • Discuss local topics in which we have shared interests from the perspective of being responsible, concerned senior citizens.
>
> • Inform and entertain within the limits of shared experiences, interests of our age group, with good taste and a civil, respectful attitude for all people.

(Blacksburg Electronic Village Seniors Purpose Statement, 1997).

It is clear that the group's emphasis on their civic role fits with the features of Erikson's eighth stage. The group's activities include an active e-mail list, a compilation of web resources (local and national covering such areas as finance, health care, and computing), and homepages for a significant number of the group. They also meet monthly in the community center.

Adapting The Internet For An Intergenerational Educational Experience

Conventionally, the Internet is thought of as a tool for bridging geographical distance. Many Internet projects, especially in the K-12 arena, reflect that facility, connecting kids with communities and classes all over the world, and generally addressing global issues (Burgstahler, 1996; Ellsworth, 1997, Wolcott, 1996). This has partly been a product of those institutions connected to the Internet, many of which have been government and education-related. However, as the number of private citizens and other institutions connecting via the Internet increases, new possibilities have emerged. One such possibility is to bridge generational or sociological distance, by bringing together those groups who are marginalized in the conventional structures of community life. This has become possible in a community like Blacksburg, because it is an experimental site for the Electronic Village concept. In BEV all citizens have been encouraged and supported in connecting to the Internet, and consequently some groups have become very active. One of these groups is the senior citizens, particularly as the community is also promoting itself as a retirement community (Blacksburg Electronic Village Vision Statement, 1994).

Project Description

The project involved many players, however, one of the goals in implementing the project was trying to make the communication technology as transparent as possible. This is especially important when introducing technologies to younger students. In addition, teachers are less likely to take time away from regular class activities when technology usage becomes too burdensome. The project was purposefully designed with the idea that the most basic of computer communication technology be used. Thus the primary source of communication was the use of the classroom e-mail system (second graders) and the seniors project listserv (senior citizens). A listserv was set up for the interactions of this group. Students sent messages to this listserv and seniors on the listserv responded as they saw fit.

Time Profile

The project was designed to be carried out throughout the school year. This included both the Fall and Spring Semesters of 1996 and 1997. After assessing if there was enough meaningful exchange, the project would be continued for the following year depending on willing participants.

Interaction Protocol

The second graders worked in small groups composing questions and comments. The seniors involved responded individually either to a particular group of students, to the list and to any message they wished. All messages between student groups and seniors were included on the Youth-Senior Listserv. Topics were selected by the teacher and centered around particular themes covered during the school year.

Supervision Of Project

Although the listserv was set up by BEV, it was maintained and monitored by the researchers. All particular messages to the students were first read by the teacher. Any needless messages that did not appear appropriate for the students could be deleted by the teacher. The teacher also supervised the messages composed by the students.

Senior Participation Of The Project

The details of how the project was to be conducted and how the seniors were to participate were established after lengthy negotiations with the seniors and the teacher involved. The seniors group is generally in high demand for internet-related projects and they generally reject most requests. Typically, this is because they do not fit with the seniors purpose and local orientation. The seniors were also concerned about their potential workload, since they typically lead busy lives. They were also concerned that the teacher take some responsibility to filter the students' messages. Having addressed these concerns, we found that the teacher was concerned that the seniors might find the experience too boring. Generally speaking none of these concerns emerged as a problem. Once both groups approved, the seniors were recruited from the existing BEV Seniors group. Presentations about the project were made via e-mail and at the group's monthly meeting, and about twenty seniors signed up for the project

Role Of The Teacher In The Project

The project was designed to enable the teacher to build in the electronic intergenerational communication into the existing curriculum. There were key themes that were developed and served as starting points for communication activity between the second graders and the seniors. This served to further represent the critical relationship between the seniors historical reflections and the existing topics covered in the classroom. It was considered important by the researchers that the project communications not exist outside of the context of the learning by the students. A secondary role of the teacher was to acquaint and assist the students with necessary skills for composing and sending e-mail messages. This included proof reading student composed messages to insure that they would be understood and not be redundant. The teacher's role included being a gate keeper for the incoming messages to insure that they were developmentally appropriate and clearly stated for the second graders to understand.

Project Assessment

In assessing the benefits of the project, the second grade teacher and senior citizens were interviewed to assess the perceived worth of the experience. Project assessment areas that were intended to be explored included:

- appropriateness for learning/teaching class concepts
- perceived worth of learning about other group
- perceived worth in building relationships with other group
- perceived building of mutual respect
- perceived similarities with other group
- perceived potential for long term and on-going relationships
- project implementation effectiveness and weaknesses

The second part of the project assessment featured the communication archives. The electronic communication between the senior citizens and second graders have been collected and a content analysis will be conducted focusing on areas and levels of engagement between the two groups as well as to provide a reference for some of the issues that emerge from the participant interviews.

The final component of the project assessment featured observations of the two groups in face to face communication in the form of two social "get-togethers" (Valentine's Day party, and an end-of-the-year park outing). The observations centered on how the two groups demonstrated ease in communicating with one another, respect for one another, and social cohesiveness.

Communication Content Analysis

The communication between the two members were categorized in the themes selected by the teacher. For the year, these themes reflected common experiences that both the second graders and seniors could easily relate to and reflect upon. The communication themes were as follows:

- Reflections on celebrating Halloween
- Traveling for Holidays
- Reflections on celebrating Thanksgiving
- Christmas Traditions
- Games that people play and watch
- Planning of a Valentines Day party
- Hobbies, interests, and collectibles
- Favorite books to read
- Favorite places to visit
- Ways of celebrating Earth-Day
- Summer Plans

It became apparent through reading the messages that the second graders' role of asking questions and the seniors' role in supplying recollections became the predominant structure of the communication. It was consistent throughout the themes that the students were interested in personal stories such as, "what was it like to go to school back then?" It became clear through reading student composed that the students were identifying with the seniors on a more than superficial nature as the project progressed. In one of the messages, the class reported to the seniors how wonderful it was to talk with them because most of their real grandparents lived far away. This included a survey the students conducted concerning how many of their grandparents lived far away. The results showed that 8 of the 14 students had grandparents who lived outside of the Western Virginia area, 10 of the 14 had students living outside of the city of Blacksburg. The opportunity for the students to interact with grandparents were severely limited, thus, the role of the seniors became more of a surrogate electronic "grandparent". The messages reflected both the students and the seniors expressing themselves in what could be interpreted as a grandparent/grandchild relationship.

Synopsis Of Senior Responses To The Project

Initially some of the seniors' responses to the teacher's postings were quite lengthy (up to five long paragraphs). The teacher soon found that she had trouble keeping up with reading the responses to the students, and asked the seniors to send responses which were about two paragraphs in length. This proved to be less intimidating to the slower typists among the seniors and led to more responses from them. The seniors responded consistently whatever the topic themes turned out to be. Generally, if they had no experience which directly related to a theme, they took the opportunity to tell stories about similar events or activities, either from their youth or from more recent events related to their own family's experience. In either case, their narrative was typically focused on particular experiences in which there was an explicit moral lesson to be drawn, essentially a form of fable. Again, this fits with Erikson's eighth stage, where seniors feel the need to communicate information to their wider community for the purpose of passing on their wisdom. It is also possible that this way of communicating might have been a product of the fact that the seniors knew that their peers would be reading their responses. Interestingly some seniors chose to respond directly to the teacher and did not post their responses on the listserv. This may have been partly a product of the technology, but it is clear that some were not comfortable with making these stories public.

This reticence is also reflected in the seniors' responses when they were asked about their role in the project directly. A typical response was that the individual was taking part in the project for the students' benefit and not for their own, even though it was clear when they were interacting with the students they were enjoying themselves tremendously. This was not only because the interaction itself was enjoyable, but also because it provided an opportunity to reflect upon their own history and they had a strong sense of creating a legacy in their community.

Synopsis Of 2nd Grade Teacher Response To The Project

The teacher was very positive about the project. The major reason for this was that it fit with her regular classroom objectives. Her students were able to use the internet collaboratively in authentic tasks that improved both their reading and writing skills. The teacher's ability to archive all the messages gave her and the students a long-term resource from which to draw that could be related to any class activity. The project brought new volunteers into the school as a number of the seniors came in on their own initiative to take part in class and school activities. This also generated new allies in the larger community, who are important to the level of support the school receives. There was also a personal benefit to the teacher as very positive publicity was attached to the school and her class in particular. The teacher also felt that the technology was particularly appropriate to the project. When asked whether other options (such as writing letters) would have worked as well, her response was "No, I have done a number of projects with letters. Children do not have that long of an attention span. [By the time that you get a letter back] so much time has passed that you forgot what you said."

Observation Of Face To Face Meeting

The result of the e-mail interaction was that when the seniors and students finally met, they already knew each other and each other's interests. By giving both groups the opportunity to get to know each other, potentially negative stereotypes were dissolved before they actually met. The internet had provided an ideal mechanism to prepare the way for very successful face to face interaction. Nevertheless, there was some awkwardness at the first meeting primarily because the seniors were unfamiliar with the physical environment, but this quickly dissipated, and was hardly evident at the second meeting.

The face to face meetings were a key component of this whole project for a number of reasons. Firstly, they provided an opportunity to get to know the person behind the experiences the students had learned about. Secondly, they enabled the students to get a more concrete understanding of what a "senior" was. Thirdly, they brought the seniors physically into the school. The first and third of these were particularly significant, because on the basis of these personal relationships and being brought into the school, a number of the seniors became volunteers and active supporters of the school.

Discussion

There are a number of key findings in this project. Although all of the issues included in the project assessment plan have not been included here, on-going assessment activities are continuing to be explored. One of the major goals for success was to see if the communication would continue throughout the school year. It succeeded because we negotiated in advance with both stockholders, i.e. the teacher and the seniors. As a result the project fit with the teacher's agenda, and with the seniors' workload. Secondly, the success of the face to face meetings (a crucial component) were successful and more effective because of the prior connections made through e-mail. Thirdly, the project generated goodwill toward the school in a community that traditionally has been generally not supportive, uninterested and unaware of school issues.

Partly for this reason, some of the other issues we intend to explore include how we can maintain seniors' enthusiasm as the project repeats from year to year. We also hope to address more directly the question of the seniors involvement and support of the school. In doing so, we hope to uncover the extent to which the seniors have an enhanced sense of belonging to their own wider community. Other directions to our research include trying similar projects in a modified form outside of BEV in communities which do not have the same level of computer ownership or internet connectivity.

Finally, this was the first phase of this project, designed in part as a pilot for other projects. The researchers did not know if the project would even last the year , but the project was successful from both the teacher's perspective and the seniors' perspective. Both groups were very interested in continuing the project, and it has continued in a slightly modified form, which the researchers intend to report on at a later date.

"Every time an old person dies, a library closes"

Regardless of whether this particular project had succeeded or not, we would have pursued this line of inquiry. Senior citizens are valuable, but too often ignored resources in our communities. The internet is a tool which can create opportunities to change that concept. Seniors can bring rich, lived experience into the classroom, and students can learn more about particular content, but they also can learn to appreciate their own history and that of their wider community.

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Training in Observation Skills for Health Care Professionals: Interactive Multimedia

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Systematic behavior observation is one method of measuring children's behavior in ecological environments and studying how their behavior compares to that of other children in the same situation or how it changes subsequent to intervention (Shores, Jack, Gunter, Ellis, DeBriere, & Wehby, 1993; Walker & Hops, 1976). The main strength of a systematic behavior observation procedure is the objectivity it brings to the description of children's behavior. Whether observing in clinical settings, classrooms, or playgroup situations, service providers in psychiatric and pediatric services find behavioral observation to be a critical skill for gathering reliable and objective data to aid in treatment decisions (Loney, 1980; Walker, Colvin, & Ramsey, 1995; Wehby, Symons, & Shores, 1995).

To become a competent observer, one must learn a behavior code and procedures, practice in simulated and real settings until proficient, meet established standards for reliability, and learn to interpret observation data. These skills take an investment in training and practice time. Typically, observers are trained through a combination of didactic instruction, work with videotapes, guided practice with a "master" coder, and "in situ" reliability checks. This training protocol is time and person intensive; it can take 40-60 hours to bring a novice observer to the minimal acceptable level of 80% accuracy. It is not feasible to spend this amount of training time on one assessment procedure within most health care training programs. As a result, full training is rarely provided health care personnel, and observational data are based on subjective, informal procedures.

An alternative delivery approach for training personnel in observation skills is interactive multimedia technology. In the *Classroom Behavior Record (CBR) Observation Training Program*, video and audio scenes of children in classrooms/playgroups and instructional narrations are stored on three videodiscs. The seven-module computer program delivers instruction through text, graphics, animation, and videodisc material; provides feedback on practice activities; and controls delivery speeds. The CBR instructional program is based on a well-established observation system used to assist in diagnosis and treatment monitoring in hospital and school settings.

Description of the *Classroom Behavior Record* Observation Procedure

CBR was developed at The University of Iowa Hospitals and Clinics by the educational staff in the Child Psychiatry Service unit (Nichols, Robinson, & Fitzgerald, 1979). Its purpose is to provide a method of systematic observation to document children's behaviors in naturalistic settings for use in diagnosis and treatment. The original CBR code was comprised of 38 positive and negative behavior codes to provide a detailed and specific description of behavior. The coding procedure involves coding the behavior of a target child in six-second intervals, while coding the behavior of peers in the same situations on alternating six-second intervals. Thus, the data provide a comparison of the target child to his/her peers under the same situational expectations. Results provide a clinical method to evaluate treatment effects through the use of normative peer data (Walker & Hops, 1976). CBR has been used continuously since 1979 in the Child Psychiatry Service unit. Primarily funded by Chapter I funds to the inpatient school program, trained professional observers gather pre-and post-data for children referred to the treatment center. These data are used to understand the youngster's difficulties as they occur in natural settings, to establish treatment goals, and to monitor treatment effects, particularly of medication. Training of professionals typically took 40-60 hours of one-on-one training with periodic re-calibration training and checking of observer reliability.

When the project developers sought to implement training in CBR for behavior specialists in educational settings, the original CBR code was found to be too complex for mastery and maintenance by school professionals. Through factor analysis procedures using hundreds of clinical CBR records, the categories were collapsed into 15 behavioral codes with 4 open variables for tracking unusual behaviors as defined by the observer (Fitzgerald, Nichols, & Whittaker, 1992). The CBR-School Version Code is now implemented in various school districts and provides the content for the current interactive multimedia training program (Fitzgerald, Semrau, Nichols, & Nichols, 1997). The original coding procedures continue to be implemented with the new code. Target and peers are coded in six-second intervals on alternating intervals. Data records are used in the special education identification procedure and by behavioral specialists to monitor the effectiveness of educational interventions for children. The code has been modified by professionals who choose to look more closely at the behaviors of special groups of youngsters, such as early childhood groups or youngsters with autism.

The codes in the CBR-School Version are:

Positive Behavior Codes	
AT	Attend/ On-task
IM	Incidental Motor
II	Instructional Interaction
PP	Positive with Peer
PT	Positive with Teacher
CO	Comply
AG	Approval Received
V1-V2	Open Positive Variables

Negative Behavior Codes	
FA	Fail to Attend/ Off-task
PL	Play with Object
MN	Motor/ Noise Obtrusive
DD	Disruptive, Destructive
NP	Negative with Peer
NT	Negative with Teacher
FC	Fail to Comply
DG	Disapproval Gained
V3-V4	Open Negative Variables

Making and Re-purposing the Videodisc

The initial videodisc was created by a production team at The University of Iowa Hospitals and Clinics with combined funding and support from the Iowa State Department of Public Instruction. The University of Iowa WEEG Computing Center, The University of Iowa Audio-Visual Department, and The University of Iowa Hospitals and Clinics (Nichols, Huntley, Lindamann, Schiele, Johnson, & Fitzgerald, 1985). Most of the scenes which were taped for use on the videodisc were authentic. Youngsters were taped in classroom and playgroup situations in a child psychiatric inpatient center over a period of months to gain as wide a variety of children as possible. To fully capture good teaching samples of behaviors, six child actors were recruited to demonstrate some of the critical behaviors needing to be taught for CBR.

When the CBR Code was revised to the CBR-School Version Code, the entire videodisc was re-purposed to teach this new code. Additional classroom video material was secured from video archives produced through a special project grant from the U.S. Department of Education (Semrau & Fitzgerald, 1992). Additional practice scenes were chosen from these archives and an additional videodisc was made to increase the number of practice-for-generalization opportunities. The current training program utilizes one side of a videodisc for the acquisition and fluency-building modules and two additional sides of videodiscs for the generalization practice modules and reliability testing.

Instructional Design of the CBR Training Program

The overall design of the training program is based on the *Stages of Learning Model* as initially described by Gagne (1974) and adapted to computer-based instruction (CBI) by Criswell, 1989. Learning is viewed as a systematic, developmental process with the learner progressing through stages of acquisition, fluency, generalization, and maintenance. Anderson (1980) describes three stages in skill acquisition: 1) a cognitive stage to learn about the skill, 2) an associative stage in which a learner practices the skill, and 3) an autonomous stage in which a learner improves the skill performance.

These models are very helpful for determining an effective instructional design for skill-based instruction. Criswell (1989) posits that effective instruction requires a match between CB I design and learner objectives as reflected in progressive, changing performance. Effective instructional design should facilitate the mastery of learning objectives at each stage in the hierarchy. The teaching approach at each stage must change to support differing goals for the learning. The schema displayed in Figure 1 depicts the organization of the CBR training program. Design of the modules within the CBR program have differing design features to support acquisition, fluency-building, and generalization of skills in behavioral observation.

Despite an overall high level of organization and structure, the modules in the training program can be accessed in a nonlinear manner to meet different learner preferences. Movement across learning activities is easily executed by opening different modules. To facilitate learner control within the modules, the program frequently stops and allows the learner to repeat segments, advance or restart drills, and check scores. In the tutorial modules, all subjects are listed on a pull-down menu which can be accessed at any time. Advisement for the learner is inserted into feedback on the drills which suggest levels of proficiency for each fluency drill. In early studies with this program, differences were observed in users' sequences, although most users follow the organizational pattern and embedded structure within the training program (Fitzgerald, 1995).

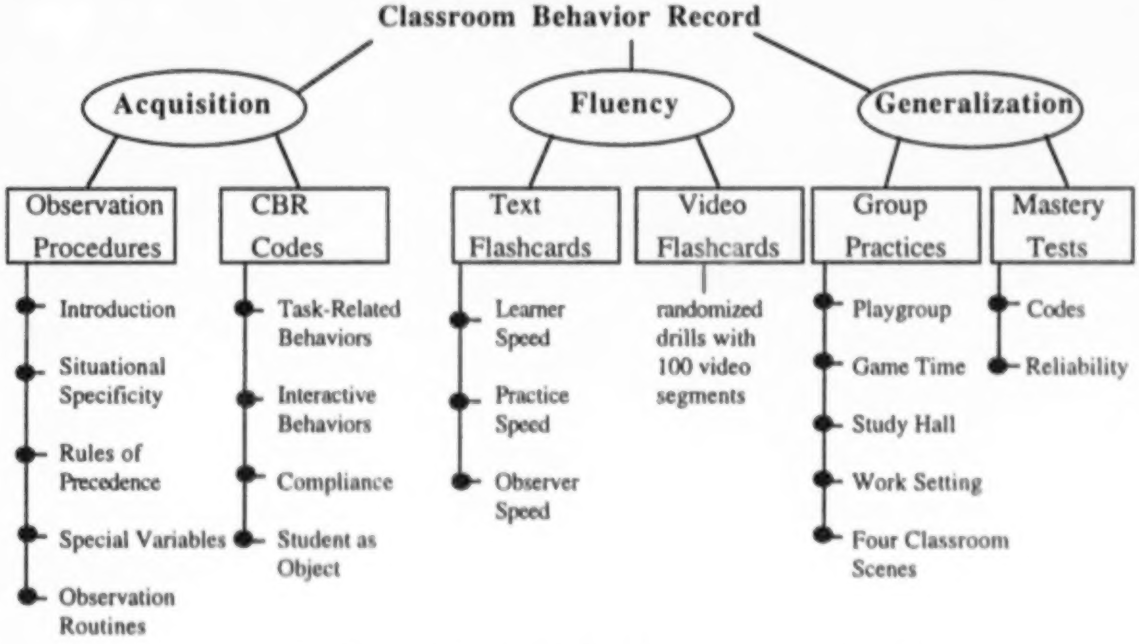

Classroom Behavior Record
Acquisition
Fluency
Generalization
Observation Procedures
CBR Codes
Text Flashcards
Video Flashcards
Group Practices
Mastery Tests
Introduction
Situational Specificity
Rules of Precedence
Special Variables
Observation Routines
Task-Related Behaviors
Interactive Behaviors
Compliance
Student as Object
Learner Speed
Practice Speed
Observer Speed
randomized drills with 100 video segments
Playgroup
Game Time
Study Hall
Work Setting
Four Classroom Scenes
Codes
Reliability

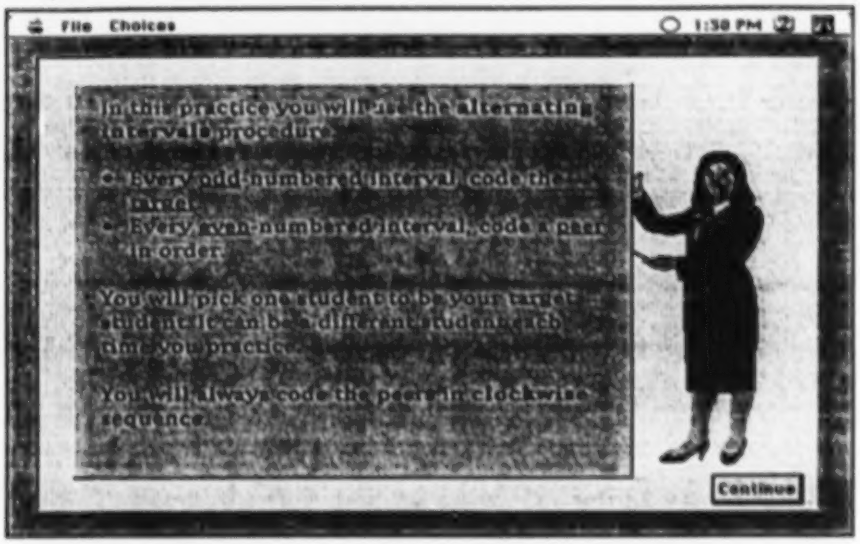
Figure 1. Matching CBR Training Modules to the Stages of Learning Model

Acquisition

The learner's instructional goal at the acquisition level is to acquire new knowledge or skills. The CBR training program includes a series of tutorials with short practices embedded within each concept or skill. The teaching hierarchy is simple to complex, based on the structure of the knowledge and skills needed in this observation system (Kelly, Orgel, & Baer, 1985). These procedural tutorials provide information through narration, screen notes, video demonstrations, and guided practice segments with feedback.

In the *Observation Procedures* module, tutorials are used to explain the importance of gathering objective observation data, studying behavior within contexts, using the open variables to define behaviors of special interest, following a hierarchy of rules for making coding decisions, and coding the child and peers' behaviors on alternating intervals. A four-minute practice is provided for the user to apply the coding rules of precedence. The practice stops at the end of each minute to allow the user to enter his/her codes and compare entries to correct answers. Another practice activity allows the user to practice the alternating interval routine with a group of four youngsters. The computer guides the user through coding one student as the target and the other three peers using the alternating interval routine. The practice stops each minute to allow the user to enter codes, see answers, and repeat if desired. See Figure 2 for an example of a tutorial screen in the *Observation Procedures* module.

In the *CBR Codes* module, the behavioral codes are taught in four groups of related behaviors: task-related behaviors, interactive behaviors, compliance, and student as object. For each code, the behavior is defined and three video examples are shown. In addition, brief practices are available within each category for practice differentiating and using the codes. When errors are made, feedback is provided to explain the critical attributes of each code. These practices are untimed since they focus on mastery of the codes, not speed of coding. Figure 3 displays the tutorial and practice choices available for the group of task-related behaviors.



File Choices
1:30 PM

In this practice you will use the alternating intervals procedure.

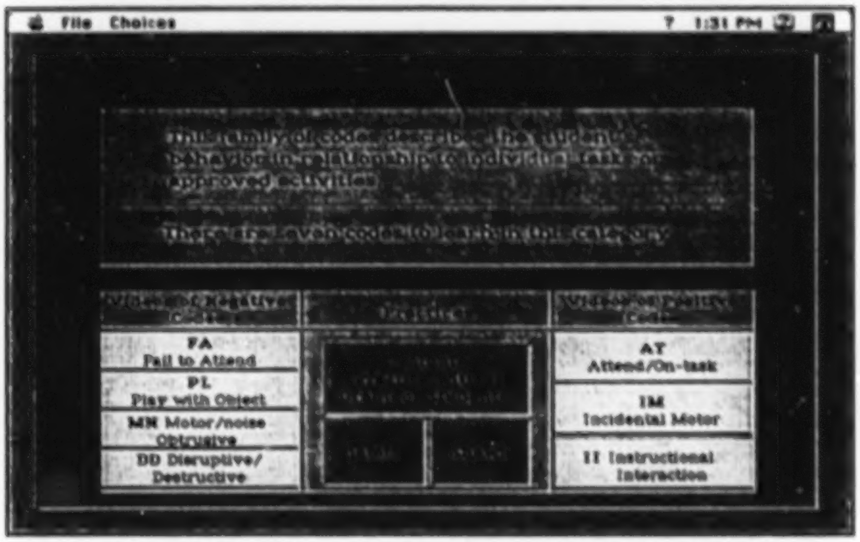
- Every odd-numbered interval, code the target.
- Every even-numbered interval, code a peer in order.

You will pick one student to be your target student. It can be a different student each time you practice.

You will always code the peers in clockwise sequence.

Continue

Figure 2. Tutorial Screen for the Observation Routine Practice



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This family of codes describes the student's behavior in relationship to individual task or approved activities.

There are seven codes to learn in this category.

Videos of Negative Codes
Practice
Videos of Positive Codes
FA
Fail to Attend
PL
Play with Object
MN Motor/noise Obtrusive
DD Disruptive/ Destructive
AT
Attend/On-task
IM
Incidental Motor
II Instructional Interaction

Figure 3. Tutorial Screen for Learning Task-Related Behavior Codes

Fluency

Following acquisition, the goal of instruction is for the learner to use the knowledge and skills in a fluent manner (Criswell, 1989). New information should become automatic so it can be recalled without undue cognitive processing. The CBR training program includes two components for building fluency.

In the *Text Flashcard* module, brief descriptions of behavior are displayed in text on the screen. The format for the text flashcard is displayed in Figure 4. There are approximately 100 text flashcards which are presented in random order at three controlled speeds, allowing a limited time to read the description and enter the user's code into the computer keyboard. The correct code is given and explained if the user enters an incorrect code or if time runs out before the code is entered. A running score is provided the user along with suggested levels of achievement for increasing the practice speed. The goal is to obtain fluency at the six-second speed needed for actual behavior coding with the CBR procedure. Rapid responding to these flashcards builds automaticity in remembering the codes.

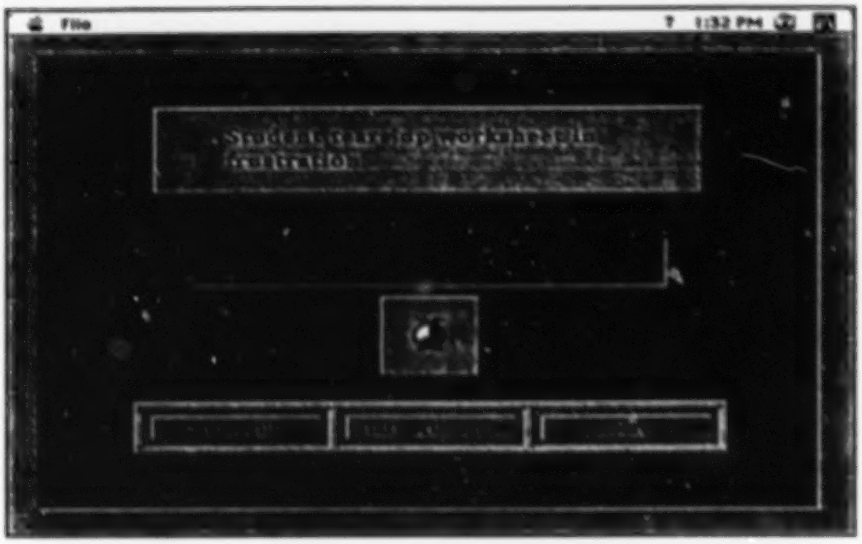

Figure 4. Text Flashcard Drill Card

The second fluency-building module, *Video Flashcards,* provides a more realistic coding simulation because it uses actual video scenes of children. In addition to continuing to build speed and accuracy, the fidelity of the practice is increased in this phase of instruction (Alessi, 1983). The format for the video flashcard is displayed in Figure 5. The flashcard module has 100 brief video clips displaying classroom behaviors which are displayed in random order. The user is allowed 3 seconds to enter his/her code following the video segment. The correct code is given and explained if the user enters an incorrect code or if time runs out before the code is entered. A running score is provided the user along with a suggested level of achievement to have mastered the fluency module of the training. Through these video flashcards, users increase their ability to rapidly interpret and code behaviors youngsters' behaviors in a wide variety of situations.

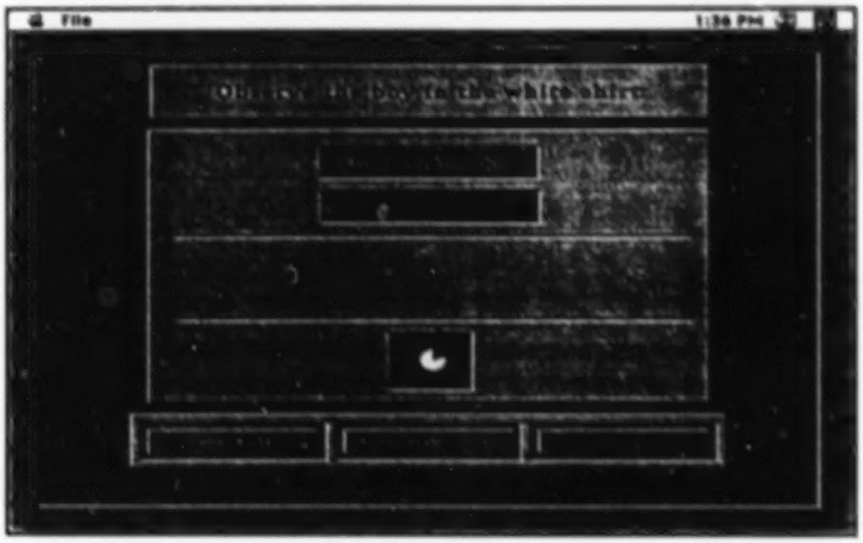

Figure 5. Video Flashcard Drill Card

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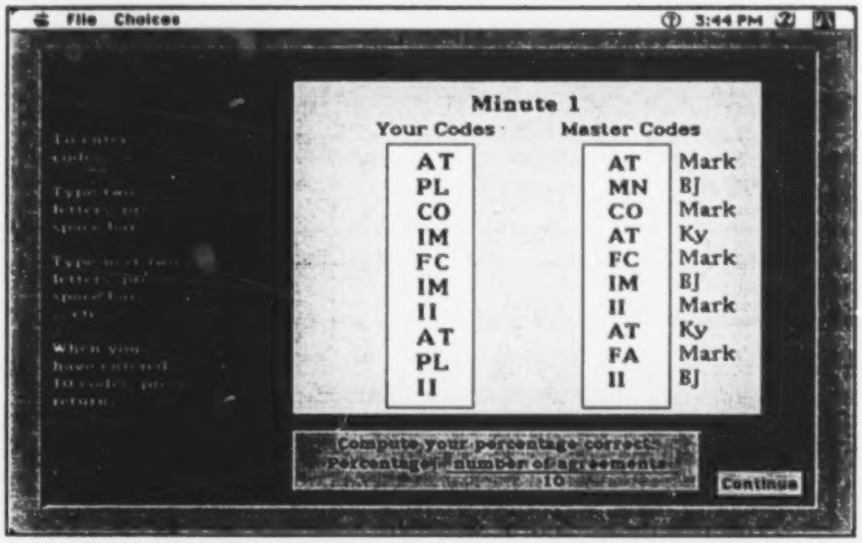
Generalization and Maintenance

Goals at the generalization stage are for the learner to apply knowledge or skills in the way they will be used "in situ" and to practice to mastery. The practice situations must be similar to those used during instruction but offer mixed practice with new, realistic scenarios (Kelly et al., 1985). Classroom and playgroup scenes are included to provide extensive practice for the learner which simulates the job of an observer in psychiatric and educational settings.

There are a total of eight scenes in the *Group Practices* module providing practice opportunities with a total of 18 different youngsters varying from ages 5 to 15. The scenes show youngsters in play group and classroom situations. These practices follow the actual CBR procedures: the user alternately codes the target student and peers with a continuous six-second interval and marks his/her codes on a paper/pencil recording form. Each segment runs for 10 intervals (1 minute) and then pauses to allow the user to enter his/her codes and compare codes to those of the master coder to discern differences and compute reliability based on the 10 intervals. The user may choose to repeat each minute for review or continue forward. Figure 6 displays the format for the data entry and comparison. In this example, Mark is the target child and BJ and Ky are peers.



Minute 1

Your Codes	Master Codes	
AT	AT	Mark
PL	MN	BJ
CO	CO	Mark
IM	AT	Ky
FC	FC	Mark
IM	IM	BJ
II	II	Mark
AT	AT	Ky
PL	FA	Mark
II	II	BJ

Compute your percentage correct:

Percentage = number of agreements / 10

Figure 6. Data Entry Screen for Classroom Application

The CBR program includes two methods for testing mastery of coding and reliability. In the *Codes Test* module, 30 video flashcards are displayed for six-seconds each and the user marks the code on a paper/pencil recording sheet. This test is designed to test accuracy in coding and allows the user adequate time to think and enter his/her codes into the computer. Approximately half the video segments are new to the user as they were withheld from prior practice. Results are provided the user following the test.

The second testing module, *Reliability Tests*, operates the same as the *Group Practices*. Four youngsters are displayed in the video, and each may be selected as the target child; thus, four reliability tests can be run in this module to check mastery and maintenance over time. The test is five minutes long (50 intervals) and the user codes target and peers on alternating intervals, marking the codes on a paper/pencil coding sheet. When the test is completed, the user enters his/her codes into the computer program and receives a reliability score.

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Methodology and Outcomes

Subjects and Training Procedure

The CBR training program has been implemented with 40 graduate students enrolled in special education courses at a mid-Atlantic university. These students were enrolled either in teacher certification programs in learning and behavioral disorders or in the doctoral program in special education. Data were collected over a three-year time period utilizing multiple instructors.

Following a general demonstration of the CBR training materials and overview of the coding categories, 25 of the users proceeded independently through all modules of the training program. For 15 of the users, a course instructor utilized the acquisition modules with the class as a whole prior to their independent use of the program. Proficiency tests were scheduled approximately 5-6 weeks after independent practice started. If required reliability levels were not achieved at the initial test session, additional practice and re-testing were required until reliability standards were met.

The data reported below are the outcome scores for each user on his/her first attempt on the outcome tests. Users were not certified for using the code and procedure in actual educational or clinical practice until the certification criteria were met. Certification requirements were met by one of two score combinations: 72% on codes test and 80% on reliability test, or 80% on codes test and 78% on reliability test. With extended practice, all but two users met criteria to be certified in CBR for actual use with children.

Training Outcomes

Usage Time. The average length of program engagement time for users to pass reliability testing equalled 15.68 hours. The range extended from 5.18 hours to 36 hours of practice time. These data do not include off-line preparation time students may have spent studying the codes.

Learning Patterns. Averaging across all 40 users, approximately 30% of on-line training time was spent in the acquisition stage of learning the code; 25% of on-line training time was spent in the fluency-building stage of learning; and 45% of on-line training time was spent in the generalization stage with simulated practice.

Outcomes on the Codes Test. The Codes Test measures knowledge of the codes. The mean score for the users equalled 76.9% (s.d. = 8.875) on their first attempt on the test.

Outcomes on the Reliability Test. The Reliability Test measures both speed and accuracy in coding. The mean score for the users equalled 80.125% (s.d. = 6.086) on their first attempt on the test.

Summary

The *Classroom Behavior Record Observation Training Program* appears to be an effective and efficient training procedure for such a comprehensive code and complex observation procedure. Comparing the training time to records established at The University of Iowa Hospitals and Clinics with the original 38-item code, training time has been reduced from 40-60 hours to 16 hours. Some of this training time difference may be related to the reduced complexity of the CBR-School Version Code with 16 categories in comparison to the 38 categories in CBR. However, it is noteworthy that these training results were achieved with minimal direct training from an instructor or a master coder sitting side-by-side with a novice observer for extensive practice using videotapes or live classrooms.

The instructional design of the training program, the authenticity of the materials, and the program's ability to provide learner-controlled instruction are important ingredients in the effectiveness of this interactive, multimedia training program. While the stages of learning model provided the overall structure for designing the training activities, its learner-centered, hypermedia interface allows users to select their own paths through the stages of acquisition, fluency, and generalization and move from cognition to autonomous skill performance.

Dissemination

As provided by grant #H029K30210 from the U.S. Department of Education grant, copies of the CBR training program are being distributed to training institutions, state departments of education, and inservice agencies. The materials are available for both the Macintosh and Windows platforms. Needed equipment, in addition to a computer system, includes a Pioneer, Panasonic, or Sony videodisc player with monitor and connecting cable. The only cost for the materials is a postage and handling charge. Eligible agencies must file an implementation plan for training initiatives. Complete information on the programs is available by contacting the authors or through the project website at: http://tiger.coe.missouri.edu/tpss.html.

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An Implementation Model for Integrated Learning Systems

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ABSTRACT

Integrated learning systems (ILSs) provide a multi-year curriculum sequence of computer-based instruction controlled by a sophisticated management system. ILS implementation is better understood when the focus of implementation is shifted from the technology to the people who use the technology. This study examined the operational patterns of teachers implementing an ILS in elementary schools in a metropolitan school district. A measure was developed that described the major components of imple7mentation of ILS technology. Data regarding the operational patterns of teachers using ILS technology were collected from teacher interviews and analyzed. The best ILS implementation practices included integration with classroom instruction, training in the use of an ILS, and the use of motivational strategies. Implementation is better understood when contextual phenomena of the implementation are examined because the question of the instructional effectiveness of an ILS or other forms of computer-delivered instruction may be as much an implementation issue as a matter of instructional design.

Introduction and Background of Study

To suppose that users of computer-delivered instruction implement courseware in the way it is intended to be used is often an ambitious assumption. Smith and Ragan (1993) advised that "in drawing the line of causation from the instruction to the results, it is critical to be able to identify the degree to which the description of the program represents what actually occurred during instruction with the new program" (p. 416). Therefore, the determination of effectiveness of computer-delivered instruction needs to begin with a determination of the degree of implementation of the instruction.

This article describes the development, validation, and research application of an instrument for evaluating the implementation of computer-delivered instruction. This instrument, the Computer-Delivered Instruction Configuration Matrix (CDICM), was designed to examine the implementation of Integrated Learning Systems (ILSs). The instrument was validated in a study by Mills (1997) involving four metropolitan elementary schools. The purpose of this paper is to describe the development and deployment of the CDICM and its implications for educational change and reform.

The CDICM was adapted from the Innovation Configuration Matrix (ICM), a tool developed by Heck, Steigelbauer, Hall, and Loucks (1981) for use in identifying the essential components of an innovation and the variations of implementation for each of the innovation components. The ICM is an effective resource for assessing implementation of instructional technology and other educational innovations (Albers, 1994; George & Hord, 1980; Gleghorn, 1993; Hord, Huling, & Austin, 1986). The ICM provides an understanding of the operational patterns of users of an innovation and therefore allows the evaluators of an innovation to make judgments about appropriate practices and how much variation in practices is acceptable (Hord, Rutherford, Huling-Austin & Hall, 1987).

Hall and Loucks (1977) were disappointed when experimental research and evaluation studies presumed the treatment was present and its effects were accounted for by testing for statistically significant differences between two groups or by pre- and post-testing the same sample. They concluded that information about the actual use and degree of implementation of an innovation might better explain some nonsignificant findings reported in evaluation and experimental studies. According to Hall and Loucks (1978) a particular innovation can have several different operational patterns as a result of variations in the selection and use of innovation components. They labeled these operational patterns as innovation configurations. Different patterns or configurations resulted when different teachers put innovations into operation in their classrooms. Individual teachers used different components of an innovation in different ways and when these components were put together a number of patterns emerged that characterized different uses of the innovation (Hord, Rutherford, Huling-Austin, & Hall, 1987).

Development and Field Testing of Innovation Configuration Matrix

The construction of the CDICM was based on a review of research on computer-delivered instruction, courseware documentation, telephone interviews with courseware developers, and interviews with vendor training facilitators, lab managers, and teachers who used the Computer Curriculum Corporation (CCC) courseware, *Successmaker*. *Successmaker* courseware covers subjects ranging from math and reading to GED preparation.

Using ICM development techniques an ICM was developed to fit with the adoption and use of the *Successmaker* ILS in varying degrees and patterns of implementation. The matrix consisted of a component checklist comprised of five variations for each component with each successive variation indicating a level of use representing a closer approximation of ideal use. Although the CDICM instrument was developed and tested with a particular ILS, its application is relevant for many forms of computer-delivered instruction.

The CDICM was devised as an instrument to be completed by an evaluator based on responses supplied by teachers during an interview. The components of technology use and variations of the components selected for inclusion on the CDICM were presumed to reflect the actual and ideal practices of teachers involved with ILS implementation. Although many forms and variations of technology adoption and use by teachers may exist, the process of instrument development attempted to reflect a true and accurate gradient of technology use from "least acceptable" to "ideal." Since truth and accuracy of instrumentation was not absolute, the intent was to develop an instrument that provided estimates that possessed known and reasonable validity and reliability.

As part of the development process, the CDICM was subjected to a two-phase field test. In the first phase interviews were conducted with a sample of ten teachers who regularly used the courseware for instruction. The purpose of this administration of the CDICM was to make revisions to matrix components and to make revisions to the interview guide. After revisions were made, the second phase of the field test was conducted to establish reliability and validity for the final version of the CDICM. A sample of nineteen teachers who regularly used the courseware completed a CDICM checklist using the revised CDICM and then five of the subjects completing the checklist were selected for interviews.

Descriptive statistics were computed for total instrument reliability. The final 15-item checklist allowed for a range of total scores from 0 to 75. The standard error of measurement for the field test was 3.68 while the interscorer reliability coefficient was .96 for all items. This administration of the CDICM checklist yielded a coefficient alpha of .61 ($p < .01$) for the total scale. The final version of the CDICM checklist and interview guide is provided at the end of this article.

Data Collection and Analysis Procedures

The final version of the CDICM was deployed in a school district that had made a substantial investment in ILS technology. ILS technology was used in all elementary school campuses in the district. The school district initially implemented ILS technology in six elementary schools and during the previous school year expanded the program to include almost all kindergarten through eighth grade students in the school district.

A lab configuration was employed at each school with a number of workstations distributed to some classrooms. Each school had a lab coordinator or media specialist to coordinate the computer lab activities and to assist the classroom teacher in the management and coordination responsibilities of the computer lab and in facilitating ILS instruction. The school principal developed a lab schedule in which all students at each school were provided forty-five minute sessions using the ILS two or three times per week to supplement regular classroom instruction.

The sample selected for this study consisted of elementary school teachers at four schools whose students interacted with an ILS using the *Successmaker* courseware for instruction. A sample of teachers (N=30) was randomly selected for the study from all of the ILS-using teachers in the four schools. The schools selected for this study had employed ILS technology for different periods of time and since the sample size was relatively small, no comparisons were made among the various schools.

To collect data regarding patterns of use occurring among individuals implementing an ILS and differences among these patterns of use, a structured interview was conducted and recorded by the researcher with each of the teachers selected for the random sample. One interview in the original selection was not completed making N=29 for the CDICM.

An expert group consisting of the researcher, an experienced lab manager (not from the school system under study), and a vendor representative was assembled to rate the interviews for the CDICM checklist. The CDICM component scores for each case in the sample were based on the collective ratings of the expert group. The expert group reviewed transcribed audio tapes of teachers' interviews and independently scored each respondent based on the content and structure of the CDICM checklist.

Analysis of use by teachers implementing the ILS was conducted through pattern analysis of the interview data to determine dominant configuration patterns or variations. The general patterns that emerged were analyzed by a cluster analysis that identified relatively homogenous groups of cases based on selected characteristics.

One-way analysis of variance was used to examine differences among the configuration patterns for each of the components measured by the CDICM. A test was performed to validate the results of the ANOVA against discrepancies that existed in the assumptions due to differences in group sizes and normality (Minium, 1978; Norusis, 1995). Post-hoc tests were performed to compare differences between pairs of configuration patterns' means for each CDICM component using the Bonferroni procedure.

An independent variable was constructed for CDICM level of use by assigning a level of use classification for the composite score of the CDICM to each case (using the same scale as was used for the component variations on the CDICM (1, 2, 3, 4 or 5). Next, a linear regression analysis was used to examine the relationship between each significant CDICM component (from the ANOVA) and the degree of ILS implementation. A stepwise multiple regression was performed to determine which components were the best predictors of ILS implementation.

Results of the Data Analysis

Reliability statistics were computed to determine the internal consistency in the ratings determined by each scorer as well as the external consistency in ratings among the scorers. External consistency of the ratings among the three scorers for all items on the scale was $r = .9926$ for AB, $r = .9974$ for AC, and $r = .9935$ for BC. Internal consistency was indicated by a significant coefficient alpha ($p < .01$) for each scorer and for all scorers combined.

Pattern analysis of the interview data was performed to determine dominant configuration patterns or variations. This procedure identified relatively homogenous groups of cases by computing the centroid for each dominant configuration pattern that emerged from the data and then assigning each case to the cluster with the nearest centroid until no cases changed cluster membership. Since the initial cluster centers and the number of dominant patterns were unknown, this procedure consisted of selecting all fifteen components of the CDICM for use in the cluster analysis and incrementing the number of clusters until a reasonable model was obtained. The number of clusters started with two and was incremented by one until convergence of cluster centers reached a distance of zero and the number of cases in each cluster was similar. The cluster analysis was run for two, three, and four clusters before a reasonable model was selected.

At two clusters convergence was achieved with a maximum distance of center change of .3205 while at three and four clusters convergence was achieved with a maximum distance of center change of .0000. At two clusters the distance between final clusters centers was 7.1883 with 18 cases in one cluster and 11 cases in the other. However, at four clusters the distances between final cluster centers ranged from 7.6997 to 17.1270 and the number of cases in each cluster ranged from 1 to 16. The best model occurred with the number of clusters set at three. When the number of clusters was set at three, convergence of cluster centers was achieved after four iterations and the maximum distance by which any cluster center changed was zero. When the number of clusters was set at three, the number of cases in each cluster ranged from 8 to 12.

In order to assess the adequacy of the classification of implementation pattern groups by the cluster analysis a Discriminant Analysis (DA) was performed. The fifteen CDICM components were used to separate the groups into the discriminant functions. As a result of this procedure all grouped cases were correctly classified.

Table 1 lists each CDICM component by $F(2,26)$ and the corresponding discriminant function coefficients and Figure 1 provides a plot of the discriminant functions for each of the CDICM patterns. The discriminant function coefficients reflected the importance attached to each CDICM component in distinguishing the discriminant functions. The multivariate analysis of variance performed by the DA produced significant differences among the Implementation Patterns on CDICM components 1, 2, 3, 4, 5, 11, and 12 ($p < .05$). Based on both functions of the DA, Pattern 2 was indicative of a high degree of implementation characterized by high training and support, integration into classroom and curriculum, and use of reinforcement and motivational strategies.

To examine differences among the CDICM configuration patterns a one-way analysis of variance (ANOVA) was performed. One-way analysis of variance determined significant differences among the implementation patterns groups for each of the CDICM components. A test of homogeneity of variance was performed to validate assumptions required by the ANOVA and to determine whether the variance of the dependent variables was significantly different among the implementation pattern groups. For the most part, the assumption of equality of variances was satisfied. However, the Levene statistic produced by the homogeneity of variance test was

Table 1. Discriminant Function Weights for CDICM Components

CDICM Component	F	Sig.	Fn 1	Fn 2
12. Uses Reinforcement/Motivational Strategies	67.8826	.0000	1.25823	-.30846
2. Received Training in Use of ILS	10.2191	.0005	.13897	.29295
5. Integrates with Classroom Instruction	9.2215	.0009	-.27445	1.74723
3. On-Going Support is Provided	7.6386	.0025	.60909	.18948
11. Facilitates ILS Instruction	6.5705	.0049	.33663	.14500
1. Understands ILS Instructional Design	3.4095	.0484	-.16839	.28902
4. Sets Instructional Goals for ILS	2.8557	.0757	-.23317	.61968
13. Uses ILS Management Reports	2.5546	.0971	-.36072	-.09096
10. Provides Sufficient Time on Task	2.1375	.1382	1.48069	-.53613
9. Sets Clear Rules of ILS Use	1.7029	.2019	-.15515	.10001
6. Integrates with District Curriculum	1.5184	.2379	.35935	-.59012
15. Understands/Uses ILS Routines and Equipment	.9081	.4157	-.07324	.08089
7. Individualizes Enrollment Options on ILS	.6088	.5516	.25277	-.42373
8. Effective Scheduling of ILS	.4905	.6179	-1.07805	-.77891
14. Uses ILS Achievement in Learner Evaluation	.3634	.6988	.14913	-.58905

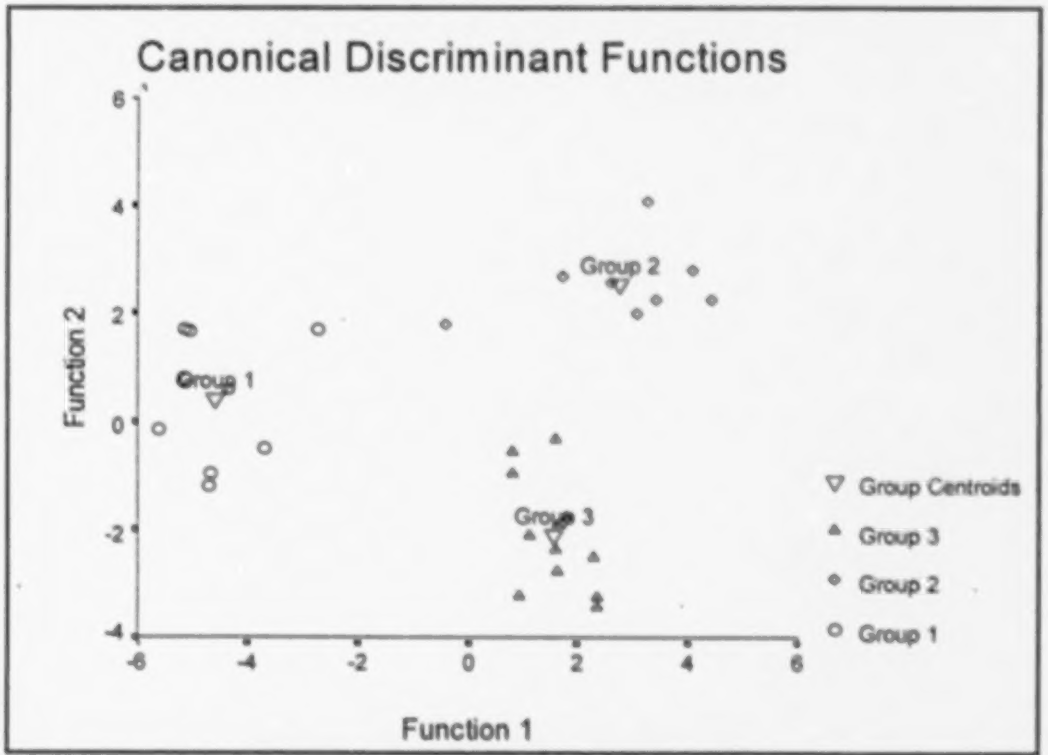

Figure 1. Plot of Discriminant Functions for Each CDICM Implementation Pattern.

significant (p < .05) for two CDICM components: Component 7—*Individualizes Enrollment Options on the ILS* and Component 9—*Sets Clear Rules of ILS Use.*

A plot of these two variables revealed that the homogeneity of variance assumption was violated by four outlier cases for Component 7 and three outlier cases on Component 9. Several attempts to transform these variables yielded no success in obtaining a nonsignificant Levene statistic and in satisfying the assumption of equality of variances and so these variables were discarded from further analysis.

An ANOVA examined the differences among the implementation patterns for each of the components measured by the CDICM (see Table 2). The observed power was calculated for the *F* test (p<.05). The results of the ANOVA were consistent with the multivariate analysis of variance performed by the discriminant analysis. The ANOVA indicated significant differences for six of the CDICM components.

To validate the results of the ANOVA in regard to violations of assumptions about differences in group sizes and normality, a Kruskal-Wallis nonparametric analysis of variance was performed. The Kruskal-Wallis test confirmed the results of the ANOVA for five of the six significant CDICM components. Only Component 1—*Understands ILS Instructional Design* yielded a significant difference on the ANOVA but not on the Kruskal-Wallis.

Table 2. ANOVA of CDICM Interview Data Grouped by Implementation Pattern

Dependent Variable		df	F	Sig.	Observed Power
1. Understands ILS Instructional Design	Between Groups	2	3.409	.048	.589
	Within Groups	26			
	Total	28			
2. Received Training in Use of ILS	Between Groups	2	10.219	.001	.975
	Within Groups	26			
	Total	28			
3. On-Going Support Is Provided	Between Groups	2	7.639	.002	.920
	Within Groups	26			
	Total	28			
4. Sets Instructional Goals for ILS	Between Groups	2	2.856	.076	.511
	Within Groups	26			
	Total	28			
5. Integrates with Classroom Instruction	Between Groups	2	9.221	.001	.961
	Within Groups	26			
	Total	28			
6. Integrates with District Curriculum	Between Groups	2	1.518	.238	.293
	Within Groups	26			
	Total	28			
8. Effective Scheduling of ILS	Between Groups	2	.491	.618	.122
	Within Groups	26			
	Total	28			
10. Provides Sufficient Time on Task	Between Groups	2	2.137	.138	.398
	Within Groups	26			
	Total	28			
11. Facilitates ILS Instruction	Between Groups	2	6.570	.005	.874
	Within Groups	26			
	Total	28			
12. Uses Reinforcement/ Motivational Strategies	Between Groups	2	67.883	.000	1.000
	Within Groups	26			
	Total	28			
13. Uses ILS Management Reports	Between Groups	2	2.555	.097	.465
	Within Groups	26			
	Total	28			
14. Uses ILS Achievement in Learner Evaluation	Between Groups	2	.363	.699	.102
	Within Groups	26			
	Total	28			
15. Understands/Uses ILS Routines and Equipment	Between Groups	2	.908	.416	.190
	Within Groups	26			
	Total	28			

Post-hoc Bonferroni tests were used to compare differences between pairs of configuration patterns' means for CDICM components yielding a significant difference on both the ANOVA and the Kruskal-Wallis (see Table 3). The Bonferroni comparisons indicated significant mean differences ($p < .05$) for all five CDICM components for configuration Pattern 2 when compared to Patterns 1 and 3 except for Component 12. These post-hoc findings indicated that differences among the configuration patterns revealed by analysis of variance were primarily based on differences between Pattern 2 and the other two patterns. Post-hoc testing validated that these differences were significant for Components 2, 3, 5, 11, and 12. Thus, teachers who implemented the ILS according to Pattern 2 were statistically better implementers than teachers who implemented the ILS according to Patterns 1 or 3.

Table 3. CDICM Components Significant at 95% Confidence Interval in Post Hoc Comparisons

Dependent Variable	Implementation Pattern	Implementation Pattern	Mean Difference	Std. Error	Sig.
2. Received Training in Use of ILS	1	2	-3.28*	1.089	.017
		3	1.31	.988	.593
	2	1	3.28*	1.089	.017
		3	4.58*	1.022	.000
	3	1	-1.31	.988	.593
		2	-4.58*	1.022	.000
3. On-Going Support Is Provided	1	2	-2.39*	.819	.022
		3	.53	.743	1.000
	2	1	2.39*	.819	.022
		3	2.92*	.769	.002
	3	1	-.53	.743	1.000
		2	-2.92*	.769	.002
5. Integrates with Classroom Instruction	1	2	-4.26*	1.084	.002
		3	-.56	.984	1.000
	2	1	4.26*	1.084	.002
		3	3.71*	1.018	.004
	3	1	.56	.984	1.000
		2	-3.71*	1.018	.004
11. Facilitates ILS Instruction	1	2	-1.76*	.608	.022
		3	.19	.552	1.000
	2	1	1.76*	.608	.022
		3	1.96*	.571	.006
	3	1	-.19	.552	1.000
		2	-1.96*	.571	.006
12. Uses Reinforcement/ Motivational Strategies	1	2	-7.64*	.769	.000
		3	-7.22*	.698	.000
	2	1	7.64*	.769	.000
		3	.42	.722	1.000
	3	1	7.22*	.698	.000
		2	-.42	.722	1.000

*The mean difference is significant at the .05 level.

A stepwise multiple regression was performed to determine significant CDICM components or combinations of components that were the best predictors of the degree of ILS implementation (see Table 4). Stepwise variable selection entered each CDICM component into the regression model by order of importance and removed components with diminished importance as additional predictors were added.

All CDICM components were entered into the regression model as predictor variables and the degree of ILS implementation as measured by CDICM composite score was entered into the regression model as the criterion variable. Significant correlations ($p < .01$) were obtained among all the variables. Component 5—*Integrates with Classroom Instruction* explained 56% of the variability in the degree of ILS implementation for this model and 54%

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for other data sets from the same population. Component 5, Component 2—*Received Training in Use of ILS*, and Component 12—*Uses Reinforcement/Motivation Strategies* explained 87% of the variability of the degree of ILS implementation for this model and 95% of the variability of the degree of ILS implementation was explained by Components 5, 2, 12, 4, and 6.

Table 4. Stepwise Multiple Regression of Influence Variables on Degree of ILS Implementation

Variable[a,b]	**R**	**R^2**	**Adjusted R^2**	**Std. Error of Estimate**
5. Integrates with Classroom Instruction	.748	.560	.544	9.39
2. Received Training in Use of ILS	.855	.732	.711	7.47
12. Uses Reinforcement/Motivational Strategies	.933	.871	.856	5.28
4. Sets Instructional Goals for ILS	.967	.935	.924	3.82
6. Integrates with District Curriculum	.974	.950	.939	3.44
15. Understands/Uses ILS Routines and Equipment	.980	.961	.950	3.11
8. Effective Scheduling of ILS	.984	.969	.959	2.82
14. Uses ILS Achievement in Learner Evaluation	.989	.978	.969	2.44
11. Facilitates ILS Instruction	.993	.986	.980	1.98
9. Sets Clear Rules of ILS Use[c]	.995	.990	.984	1.77

[a] Dependent Variable is Degree of Implementation
[b] Stepwise Method, Probability-of-F-to-Enter <= .050, Probability-of-F-to-Remove >= .100
[c] Probability of F-to-enter = .050 limits reached

Implications for Educational Change

Current debate in the field of educational change has concentrated on contrasting differences in reductionist and holistic orientations to scientific inquiry (see Banathy, 1995). Carr (1996) explained this debate by suggesting that integration and separation represented two fundamentally different aspects of the same reality. Integration was concerned that when a system was separated or reduced to smaller components some of its vital properties were lost while separation was concerned that the whole was too complex to be studied or understood in its entirety.

The problem with the approach of the first decade of computer use in schools was that it was focused on applying the computer to the existing instructional delivery system. Collins (1991) described American schools as a self-sustaining, interlocking system of institutions consisting of age-graded schools, multiple-choice testing, curriculum and materials, teacher education, and lecture and recitation that naturally resisted technology:

> If you try to introduce computers for students to do their work, the change will be sustained only to the degree that it fits the prevailing institutional structure. Since computers undermine the lecture and recitation methods of teaching and promote the student as self-directed learner, they do not fit this institutional structure and will be squeezed out by it. (p. 32)

However, for systemic change to occur the focus of change must become our view of the role of the teacher in implementing technology. Many researchers in the field of educational change are applying the principles of holistic thinking to the creation of new systems of human learning through methodologies that focus less on end goals and outcomes and more on helping individuals change their perceptions of themselves (Carr, 1996). The methodology followed by this study—emphasizing ILS implementation factors and focusing on users of ILS technology—and the subsequent data collection and findings support a systemic change process in education.

The findings of this study provided evidence for the proposition that not all ILS use is the same. Significant differences and variances in both the ILS implementation concerns and behaviors of teachers implementing an ILS were noted. The level of ILS implementation was a function of implementation practices that included integration with classroom instruction, training in the use of an ILS, and the use of motivational strategies.

Furthermore, using an ILS to improve the teaching/learning process was more complex than earlier understood. Just because a teacher was an effective implementer of an ILS was no guarantee that learners realized higher achievement using the ILS. Without the necessary organizational support the expectation for instructional technology to improve the teaching and learning process cannot be sustained.

This examination of the practices of teachers implementing an ILS can be a highly effective guide to actions that change agents and stakeholders might follow as they assume a role in facilitating change and improvement in the

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implementation of ILS technology. Given the context of ILS implementation, the findings of this study substantiated the research on change and innovation. Several lessons from the change literature were revealed through this study that might assist stakeholders or change agents in promoting a successful and effective implementation of computer-delivered instruction:

1. Implementation of an ILS is a developmental process that must be nurtured and sustained. Implementation of an ILS doesn't happen by itself. When left to their own devices, teachers will implement an ILS to whatever level is consistent with their concerns about the ILS and structurally fits into their existing teaching patterns and practices.
2. Teachers implement an ILS in different ways. The specific operational components of the ILS must be communicated to teachers so they understand what the program looks like when it is fully functioning. Before learner achievement data can accurately be examined to determine the effectiveness of the ILS, it must be determined to what degree the ILS has been implemented. A determination of the relative merit of an ILS should be based on an examination of the degree to which an ILS is actually used in relation to the intended use of the ILS.
3. Integrate ILS instruction with classroom activities and instruction. For systemic change to occur in the teaching/learning process, the existing system has to be fundamentally replaced with an improved system. Teachers that were the most effective implementers of an ILS incorporated ILS instruction into classroom instruction or vice versa.
4. Training should be a continuous process and not a one-time event. On-going training is a key component to sustaining an ILS implementation. On-going training reaffirms fundamental practices that focus the user on the intended use of the ILS and influences the concerns a user will have about the implementation of an ILS.
5. ILS implementation must be teacher-driven. There is a perception that an ILS runs itself (Gleghorn, 1993) and by simply placing learners with computers does not ensure that they will grasp the underlying structure of important ideas and concepts. Resnick and Johnson (1988) noted that learning that occurs in isolation is not sustained in other contexts and Pea (1988) explained the necessity of teachers to assist learners in applying principles in multiple situations. Effective teaching practices accommodate effective ILS implementation
6. An understanding of how the ILS is to be used and the expectations for learning must be clearly articulated. Jones (1990) observed that change is more manageable and occurs more easily when school districts articulate a common perception about what the change process entails. Once an ILS goes into a school building it is beyond the control of the designers and developers and it becomes the responsibility of the stakeholders in the change process to ensure that the ILS is properly implemented and that systemic change occurs

Conclusions

This study focused on describing the concerns and implementation practices of teachers implementing an ILS. Computer-delivered instruction and integrated learning systems represent one stage in a long succession of technologies and innovations embraced by education in the last several decades. Although the problem of implementing ILSs is relatively new, the issue of properly or adequately assimilating technology into the classroom and promoting its effective use has long been a matter of research and debate. Since the implementation of ILSs is a complex process, further studies that describe the implementation process for ILSs should be conducted.

Implementation is better understood when contextual phenomena of the implementation are examined because the question of the instructional effectiveness of an ILS or other forms of computer-delivered instruction may be as much an implementation issue as a matter of instructional design. Ultimately, the potential of ILSs and other forms of computer-delivered instruction may be unfulfilled when the technology is ineffectively or improperly implemented.

Computer-Delivered Instruction Configuration Matrix
Integrated Learning System

Rules for Rating:

(1) Any information in the interview may be used to rate any single component.

(2) Rate to the highest level of use described by the respondent for any single component.

	5	4	3	2	1
	IDEAL USE	ACCEPTABLE USE		MINIMIMAL USE	UNACCEPTABLE USE
Component 1 Instructional System and Design of ILS	Describes individualized prescriptive strategies	Describes instructional presentation and mastery of skills	Describes enrollment levels	Describes different content areas only	Has no understanding of instructional design or no understanding is necessary
Component 2 Training in Use of ILS	Initial training, continued training, and program updates are conducted	Initial training and continued training is conducted	Initial training or orientation is conducted	Training is self-directed and occurs on-the-job	Received no training
Component 3 On-Going Support System and Communication in Use of ILS	Formal grade/ department level meetings to discuss ILS are conducted	Building level meetings with vendor or principal to discuss ILS are conducted	Technology committee meets periodically to discuss ILS instruction	Informal discussions with lab manager or other teachers	No attention is given to on-going support
Component 4 Instructional Goals or Expectations for Use of ILS	Accomplishment of goals is celebrated	Instructional goals for ILS are accomplished	A plan for accomplishing instructional goals is stated	Goals or expectations for ILS are stated	No goals or expectations for ILS instruction are set
Component 5 Integration of ILS Courseware with Classroom Instruction	ILS is used as a tool for regularly accomplishing classroom instructional objectives	Plans lessons that integrate ILS courseware with classroom instruction in multiple subjects (Worksheets may be used)	Plans lessons that integrate ILS courseware with classroom instruction in one subject (Worksheets may be used.)	ILS courseware supplements classroom instruction	ILS courseware is not integrated with classroom instruction
Component 6 Integration of ILS Courseware with Curriculum	Sequence and selection of courses/lessons are adjusted to align with or support district curriculum	ILS courseware supplements district curriculum in multiple subjects	ILS courseware supplements district curriculum in one subject	ILS courseware is correlated to district curriculum when possible	ILS courseware is not integrated with district curriculum
Component 7 Appropriate Selection of Courses, Enrollment Levels, and Options of ILS	Individualized learning sequences are designed and modified based on test scores, monitoring student progress, forecasts of learning gains	Learning sequences are individualized for each student based on test scores or monitoring of student progress	Test scores or prior ILS performance are used to enroll students in same courses at different grade levels	Students are enrolled in same courses at grade level	Students are enrolled at beginning level of course or strand
Component 8 Effective Scheduling of ILS	All students are scheduled for regular use and makeup sessions are provided	All students are scheduled regular use	Some students are scheduled for regular use	Some students are scheduled for occasional, remedial or specialized use	Students are not scheduled for either occasional or regular use

	5 IDEAL USE	4 ACCEPTABLE USE	3	2 MINIMIMAL USE	1 UNACCEPTABLE USE
Component 9 **Clear Rules for Daily Procedures Using ILS**	Orientation to rules and procedures is presented	Rules and procedures are established and handed out to students in printed form	Rules and procedures are established and posted in lab or classroom	Some rules and procedures are established by the teacher	No rules and procedures are established
Component 10 **Sufficient Time on Task for Each Student Using ILS**	Amount of instructional time is determined by targeted gain for students	Students receive more than 30 minutes of ILS instruction per week and makeup sessions are provided	Students receive more than 30 minutes of ILS instruction per week	Students receive at least 30 minutes of ILS instruction per week	Students do not receive regular weekly instruction using ILS
Component 11 **Teacher Facilitation and Intervention Using ILS**	Continuously facilitates instruction; provides intervention strategies including worksheets, selected practice, tutoring, or small group instruction	Continuously facilitates instruction	Occasionally facilitates instruction or facilitate when students request assistance	Facilitation and intervention Is provided primarily by lab manager	Teacher is not present or does not facilitate ILS instruction
Component 12 **Effective Use of Reinforcement and Motivational Strategies Using ILS**	Recognizes individual and group achievement through use of individual and group motivational strategies of motivational strategies involving parents or community sponsors	Recognizes individual achievement through use of individual motivational strategies including certificates, wall charts, or individual competition	Recognizes group achievement through use of group motivational strategies including contests or team activities	Explains reasons for using ILS and encourages students to actively participate in ILS instruction	No motivational strategies or activities are used
Component 13 **Student Feedback and Use of Reports Generated by ILS**	Reports are used to provide information for determining classroom instruction or classroom activities	Reports are used to review student progress and modify student enrollment	Reports are used for progress review by lab manager, teacher, or principal	Reports are used infrequently or on a limited basis	Reports are not run or distributed
Component 14 **Instructional Assessment of ILS Courseware**	Evaluation or assessment of students includes mastery levels, lesson completion, or courseware content for multiple subjects	Students receive a letter or numeric grade for ILS achievement in multiple subjects	Students receive a letter or numeric grade for ILS achievement in one subject	ILS is optional for inclusion in the evaluation or assessment of students	ILS is not included in the evaluation or assessment of students
Component 15 **Teacher Knowledge and Skills Using ILS Routines and Equipment**	Familiar with course content for multiple courses, can modify instructional levels or other student enrollment information, and can use custom reports or forecasting reports to make instructional decisions	Familiar with course content for multiple courses and can modify instructional levels or other student enrollment information	Familiar with course content and student resources for multiple courses	Familiar with course content and student resources for one course	No familiarity with course content, student resources, or management system

Interview Guide for the Computer-Delivered Instruction Configuration Matrix

Is it OK if we use the term ILS to stand for the integrated learning system including courseware, computers, and lab?

1. Describe in your own words the organization of ILS instruction?

2. How much formal training have you had in the use of ILS? What training have you received lately?

3. What formal or informal communication such as meetings or discussions has occurred to support you in the use of ILS? (What do you do and who do you tell if you have a problem?)

4. What goals or expectations do you set for your class for ILS instruction? How do you determine if these goals are accomplished?

5. When planning for classroom instruction, how do you integrate or coordinate ILS instruction into classroom activities?

6. Does ILS integrate with district or grade level curriculum? If so, in what ways and with what courses?

7. How do you determine the courses, level, and sequence of instruction students receive using ILS? Are modifications to student enrollment ever made? If so, how do you determine what modifications are made?

8. What students in your class receive ILS instruction? Are makeup classes provided for when students miss ILS instruction or when your class misses a scheduled lab time?

9. Have rules or procedures been established for students using ILS? If so, how do students know these rules or procedures?

10. How much time do students spend each day or week using ILS? How do you determine the amount of time students spend using ILS?

11. What do you actually do while the students are using ILS?

12. How do you keep students motivated about using ILS? (Are there organized programs in your classroom or school to recognize student achievement using ILS?)

13. How do you use the student reports generated by ILS? Is this information reported to the principal or lab manager? If so, how do they use the reports?

14. Is ILS included in your evaluation and assessment of students? If so, in what ways do you use ILS for evaluation and assessment of students?

15. What courses on the ILS are you most familiar with? What routines on ILS can your perform (student reports, custom reports, enrollment)?

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Personalized Independent Learning Systems in High Technology Environments

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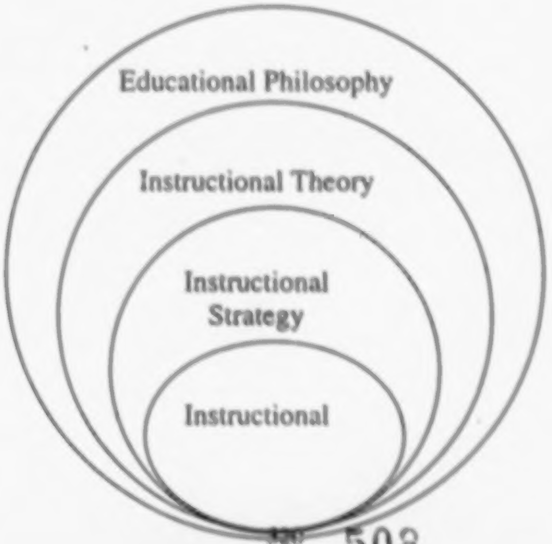
Personalized Independent Learning Systems

The 1970s saw the birth of a new concept in education: individualized instruction. Technologies such as intellectual assessment, programmed instruction, and standardized testing caused educators to rethink traditional, group based instruction and develop a wave of individualized education systems. (Armstrong & Savage 1983, Bangert, 1983, Blackburn, 1976, Dunn & Dunn, 1972, Wilson & Tosti, 1972). However, by the mid 1980's individualized instructional systems lost momentum. Reports such as the Bell Commission described the United States as "a nation at risk" due to its failing educational system, and educational reforms such as American 2000 called not for fundamental changes in the way education is approached, but only for higher educational standards (Seymour & Seymour, 1992). As the 1990s continue, little seems to have improved for American schools and theorists such as Reigeluth argue that American schools can improve only by committing to systemic, systematic restructuring (Reigeluth, 1992).

Instead of offering piecemeal solutions to educational change, educators need to offer solutions that address educational issues systemically and provide an overarching purpose or philosophy of education (Reigeluth, 1992, Postman, 1993; 1995). Although many educational theorists abandoned individualized instruction in the 1970s, *individualizing* instruction still hold promise as a an overarching philosophical approach to education. By integrating educational strategies that are known to be effective, such as reinforcement, individual pacing, providing feedback, mastery learning, and cooperative learning into a unified framework for education, educators might be able to develop functional educational systems that address students' needs (Walberg et. al, 1984). As emerging information technologies make implementing these strategies more feasible than ever before, the time to rethink individualizing instruction has come (Reigeluth, 1992).

Theoretical Framework: Personalized Independent Learning Systems

Bichelmeyer (1997) provides a framework for rethinking individualized instruction. She suggests that educators should think of individualized learning as an overaching philosophy of education with corresponding instructional theories rather than only an instructional strategy.



Therefore, in order to be effective, instruction must be more than tailored to the individual, it must be a part of a larger system designed to support individualized learning. An effective individualized instructional environment is a dynamic system; it involves instructors who embrace the concept of individualizing instruction, it provides students guidance throughout their educational lives, attending to their individual needs. Bichelmeyer has termed this type of environment a "Personalized Independent Learning System" (PILS).

In a Personalized Independent Learning System, the learning experiences are personalized in two ways: the content chosen reflects an individuals' needs, and the learning process reflects an individual's needs. Independence is encouraged in PILS by focusing on producing autonomous, self-regulated learners. Emphasis is placed on developing learners' metacognitive and critical thinking skills and ability to function as experts within their domain, rather than on producing students who can complete a narrow range of instructor derived tasks. In a PILS, learning is more important than instruction; unlike earlier individualized instructional environments, a PILS environment is characterized by learning outcomes rather than the instructional materials involved. Last, a PILS approaches education systemically; individualized instructional approaches typically are confined to particular materials, whereas a PILS is an educational system, designed with supports and mechanisms needed to support personalized learning.

Networked computer technologies such as teleconferencing, the World Wide Web, and email can provide valuable support to PILS. Teleconferencing can allow for groups of learners with similar needs and goals to meet irrespective of location. The World Wide Web is a resource that can provide a wealth of information to learners in the form of online textbooks and tutorials. The web can also support communication and organization within a group of learners, as they post information, and consult course information on line. Last, email can provide students an instructors asynchronous communication. Via email, instructors and students can exchange ideas irrespective to locale and with greater ease and convenience. This research project examines a series of design courses that are an example of a PILS and evaluates how technology is used to support a PILS.

The design model chosen is being used in a series of courses delivered via distance education to high school students and to a group of adult distance educators. The course utilizes the World Wide Web, email, interactive teleconferencing to support individualized learning over a distance. The researchers are using videotapes of the interactive teleconferencing sessions, surveys of students and teachers, and analysis of student reflections in order to evaluate the efficiency, effectiveness, and appeal of these courses and generate recommendations toward the revision of the PILS instructional design theory. Special attention is also directed at assessing the ill-defined learning outcomes associated with teaching design.

The presentation will discuss the theoretical framework of PILS and explore its ramifications. The presenters will share their findings on the strengths and weaknesses of the design model and give recommendations on how to use technology to support and create PILS.

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